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The Alaska Boundary Survey.

By D. W. EATON.*

As early as 1825 the boundary line between Alaska and Canada was agreed upon by Russia and Great Britain, but the maps of that day, furnishing the data on which this treaty was founded, were so meager in detail that room was left for controversy. Discovery of gold in the Yukon basin made it necessary to locate this line more definitely. After some discussion there was appointed a commission of six, two from Canada, one from Great Britain, and three from the United States. This commission met in London in 1903 and decided the width of the strip of land along the sea coast from Portland Canal northward to Mt. St. Elias and the 141st meridian.

The commission selected, for the most part, certain well defined mountain peaks that shall be the boundary points, and designated them upon the maps by certain marks, the reaches between the points marked on the maps being straight courses. The location and permanent marking of the boundary was left to two commissioners, Mr. O. H. Tittmann, Superintendent of the Coast and Geodetic Survey, for the United States, and Dr. W. F. King, Chief Dominion Astronomer, for Canada.

PROLONGATION OF THE 141° MERIDIAN: PROJECTING THE LINE AND SIGNALING WITH HELIOTROPE.
(Photo by Baldwin.)

The difficulty of marking the line from peak to peak is very great and the difficulties are not well understood by one who has not traveled over the country adjacent to the line. In southeastern Alaska, it is not practicable to follow the boundary line, and it is necessary for the parties to follow the streams from the coast until the line is reached, climb to some boundary point, or, if this is not practicable, determine the line trigonometrically, line in across the valley, cut out a vista 20 ft. wide through the timber, and set permanent monuments.

PHOTO-TOPOGRAPHIC WORK.—Owing to extreme climatic conditions, taking topography by ordinary methods along this section of the boundary would be extremely expensive and impracticable. The topographic maps are therefore made from photographs. Inaccessible boundary peaks are photographed with telephotographic instruments to enable the commissioners to indicate and permanently fix the exact turning point on the boundary line at these points.

A specially designed instrument is used in making the photographs. With a view to simplicity of structure and light weight the instrument has been made in three distinct parts, the transit, the camera, and one tripod serving for both.

The transit, Fig. 2, is dismounted by removing two capstan-head screws which unite the base-plate of the Y-support with the vernier plate of the horizontal circle, so that the superstructure, embracing the Y's, telescope and vertical circle, may be lifted from the horizontal circle. The camera, complete as such, may now be mounted on the vernier plate of the horizontal circle. Fig. 3 shows the camera-theodolite in its usual position, Fig. 4 in erected position. The truncated aluminum cone under the camera box is secured to the latter by means of a central clamp screw (within the hollow cone), and the base-rim of the cone is then fastened to the vernier plate of the horizontal circle by the same two capstan-head screws that secure the transit superstructure.

The substructure (with the horizontal circle) is connected to the tripod by means of the triangular tripod plate. This triangular plate is screwed to the tripod and the three leveling-screws of the substructure are placed on the arms of this plate. A clamping device securing the conical ends of the leveling-screws to the tripod plate serves to prevent a possible disturbance of the substructure when the exchange from transit to camera is made.

The adjustments of transit and camera are stable and with ordinary care are little liable to change. To reduce weight without sacrificing rigidity and strength, aluminum has been used where practicable. The camera is packed in a stout packing-case, together with eight double plateholders, focusing-cloth, note-book, etc. The transit is packed by itself.

The rear frame of the inner (aluminum) camera-box is supplied with notches to mark the horizon and the principal lines. The constant focal length (about 151.64 mm.) of the lens is also laid off on the inner edge of the frame, one-half on either side of the principal line and one-half on one side of the horizon line. All the notches print on the edges of the negatives, giving ready means for checking distortions in the prints.

The camera-box is arranged with sets of cross-levels so that it may be leveled in the different positions shown in Figs. 3 and 4.

In using the instrument the observer sets up at a station, say a peak which commands a good view in every direction, and orients himself by pointing on a known triangulation station, reading angles to other stations and to all prominent topographic points. He takes angles to some points that may be easily recognized on photos to be taken later. Usually he gets two such points on each photo for the purpose of orienting the pictures and controlling the elevations. The camera is now substituted for the telescope and the plates exposed. These are 5 × 8-in. plates. The lens cuts 60°, so that six plates make a complete round or panorama. From these plates the elevations and distances are taken by applying the principles of perspective. This is in reality carrying the plane-table work into the office, and a small field party can map a very large area of country in a very short time at comparatively small cost.*

MERIDIAN MARKING.—There never was any dispute about the 141st meridian, and the marking of that part of the line is now in progress and is rapidly nearing completion. Here the conditions are such that packhorses may be used and the ordinary methods of mapping may be used. The method of projecting this long line may be of interest. So far as the writer is aware this is the longest straight line ever projected.

*Surveyor, Alaska Boundary Survey, Washington, D. C.

*For a more detailed exposition of this method see "Photo-topographic Methods and Instruments," by J. A. Flemer, published by John Wiley & Sons, N. Y.

The initial point of the 141st meridian was determined by longitude observations (telegraphic) where that meridian crosses the Yukon River. The azimuth was determined astronomically and the line projected both north and south. This point was approximately halfway from Mt. St. Elias near the southern end to the Arctic Ocean at the northern end.

In the projection of this long line a micrometer instrument is used, and the party consists of an observing party and two heliotrope parties. The observing party is made up of one Canadian and one United States observer. The observing party (see view on p. 495) occupies the last known point on the line, backsighting on one of the heliotropes set over the point behind. In getting the point ahead the forward heliotroper is sent ahead 15 or 20 miles and placed approximately on line. Usually some prominent ridge ahead is selected, and the heliotrope is set as near the line as can be judged. Then a set of readings is taken with the forward heliotrope on the east side of the line. Then another set is taken with the heliotrope on the west side of the line. Usually these two heliotrope stations are 6 or 8 ft. apart. The two observers take the sets, one as soon after the other as possible, so that conditions shall be nearly alike. The proportional mean of the two observations is measured from the heliotrope stations and marked as the new point ahead. The rear heliotrope is then signaled forward and the heliotrope set over the station occupied, and the observing party moves ahead to the new point. Signals are erected over all these points and they are connected by the triangulation carried along the whole line.

The triangulation and topography are carried on by small parties, each having a pack train to move its camp equipage and keep up provisions whenever necessary. There is one pack train whose business it is to distribute the whole season's provision supply, and in case of necessity come to the relief of any party within reach needing its assistance.

MERIDIAN TOPOGRAPHY.—The organization of the various parties is as follows: A small reconnaissance party, consisting of an expert in reconnaissance and one assistant or recorder, plans and lays out the triangulation scheme and erects signals. This party is attended by a cook and a pack train with two packers. The observing party consists of an observer and one assistant or recorder, a cook and a pack train similar to that of the reconnaissance party. This party occupies each station of the scheme, cutting in all prominent topographic points (such as sharp peaks) and the signals erected along the line by the line party. A 6¼-in. theodolite reading to 10", with a 4-in. vertical circle reading to 10", is used for this work. Each single angle in the scheme at each station and the outside angle necessary to close the horizon are measured. No sum angles are measured. Each measurement of every angle is immediately followed by a measurement of its explement. Six repetitions constitute a measurement. If the closing error in any triangle is as great as 6" the observations are repeated. An effort is made to keep the average closing error down to 2", and under normal conditions this degree of accuracy is generally obtained.

In observing vertical angles, the vertical circle being graduated from 0° to 360°, zenith distances are recorded, i. e., the angles from the zenith to the points observed upon. The angle of elevation

FIG. 1. MAP OF ALASKA, SHOWING THE BOUNDARY, AND DETAIL MAP OF THE SOUTHEASTERN PORTION.
(Sketched from U. S. C. & G. S. Chart "Dixon Entrance to Cape St. Elias," and U. S. G. S. Map A.)

is the algebraic difference between the zenith distance and 90°.

When all the angles have been observed in any quadrilateral the positions of the new points are computed and furnished the plane-table parties following, who are doing the topography.

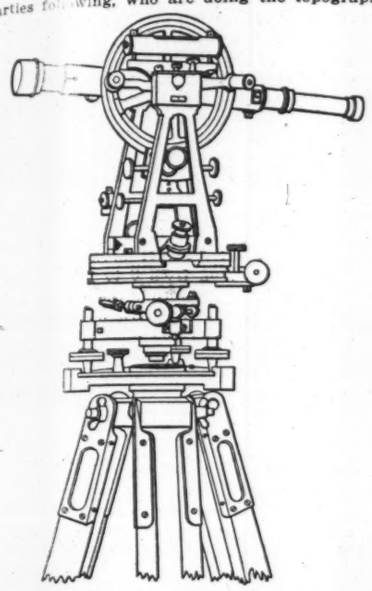

Fig. 2. Transit of Photo-Topographic Instrument.

They plot these points on their projections or plane-table sheets. The plane-table parties traverse streams and ridges and map a strip four miles wide, on a scale of 1 : 45,000, with contour interval of 100 ft.

MONUMENTING.—The line cutting party and the monument setting party follow last. The vista is cut 20 ft. wide along the line, 10 ft. on either side. Timber becomes more sparse and scrubby on the way north, and north of the Yukon the ridges are bare, with scattering trees along the streams.

Monuments are of aluminum bronze, set in a concrete base, Fig. 5. A hole is dug out deep enough to insure a footing in the frozen ground, which is encountered at a depth of 15 ins. in August. Cement, sand and broken stone in the approximate proportions 1:3:5 are used, with a top dressing of richer material.

Transportation Along Alaskan Boundary.*

The matter of transportation along the boundary is always one of the greatest problems with which the various parties have to contend.

On the coast, along the southerly part of the boundary, this resolves itself to the simplest form. Steamers land men and equipment at the nearest harbor to the scene of operations. From a base so established, parties and supplies are taken by launch as far up rivers or inlets as navigation will allow. Here all hands don rubber boots and man the canoes or poling-boats. Where possible, the boats are poled or rowed, and when the current becomes too swift the tracking line is thrown over the shoulder and the boat slowly breasted against the rapid waters. A time comes when the boats have to be abandoned, a cache of supplies is made and the members of the party, stripping themselves of all superfluous dunnage, resort to the various forms of packs. Some use the tump line or head strap, while others use the plain back strap. On broken glaciers, the life line connects each man with the other. One hundred pounds is the average pack, and when this is continued for days the strain at times becomes almost unendurable.

In the interior, along the 141st meridian, numerous complications arise. On the pack train mainly depends the success of the season and the safety of the party; but in covering 100 to 200 miles of boundary a year, if entire dependance must be placed in the pack train, then it would be necessary to put a herd of enormous size in the field. In consequence, bases of supplies are established usually upon navigable rivers or streams. To these bases come the provisions and feed for the horses. Then the various trains distribute supplies as they are needed along the train. A typical instance may be taken of the season of 1909.

THE 1909 SEASON.—During the winter some 20 odd tons of supplies were taken to a point near the boundary crossing of the White River, from Whitehorse, and there cached. Another 5 tons were taken from the mouth of the White up the river from the Yukon and cached on Scottie Creek, about 100 miles north of the first cache. There were also distributed along the line of march sufficient oats and supplies to last the parties on their long journey of 300 miles from Whitehorse.

In the spring the main party of about 40 men and 60 horses took the trail, carrying with them only their personal belongings, tents, bedding and such articles as could not be shipped during the winter. This journey was accomplished in seventeen days, part of it being over exceedingly mountainous country. Rivers and lakes were crossed on the ice.

Upon arrival at Canyon City, on the White River, the several independent parties were organized, each with its own pack train. One party, going light, headed north and took up work near the Scottie Creek cache, while the others were supplied from White River. In addition to the camp trains, a supply train of 14 head of horses was continually on the move,

Fig. 5. Monument on the Alaska Boundary.
(Aluminum bronze on concrete base.)

moving oats and provisions to convenient points along the boundary.

At the close of the season, all the parties reassembled at White River and once more moved out over the long trail.

WORK FOR 1911.—During the coming season, the work of the joint American and Canadian parties lies between lat. 67° and the Arctic Ocean. The matter of transportation has become of grave importance. The plan adopted by the American and Canadian Chiefs of Party is in substance as follows: Supplies will be landed at Rampart House. From this point four 16-horse supply trains will operate both north and south. Each government furnishes two 25-HP. stern-wheel launches, pushing barges. These ply between Rampart House and the boundary crossing of the Old Crow River. The greatest difficulty now to be encountered is that the native grasses have almost entirely disappeared, and not only must oats be packed for the stock, but hay also. The pack outfits have been doubled, and each government must now put over 100 head of horses in the field. At the boundary crossing of the Old Crow will be established the main base of supplies. During the winter a party of freighters will be kept in to push supplies well up toward the Arctic Ocean. In the main, horses will be used to haul the toboggans and double-enders, but in case the weather should prove too severe for horses a reserve of dog teams will be ready for immediate use.

The life of the horse or dog freighter during the winter will not be an easy one. The thermometer ranges from 40° to 70° below zero. For two months there is not even a glimpse of sun. The big gray timber wolf hunts in packs; so on every sled must be fastened a riot shotgun loaded with buckshot. Fifteen men will have to winter in the North, but when spring once more comes the supplies will be distributed, so that work can be started without delay and continued throughout the short summer to completion.

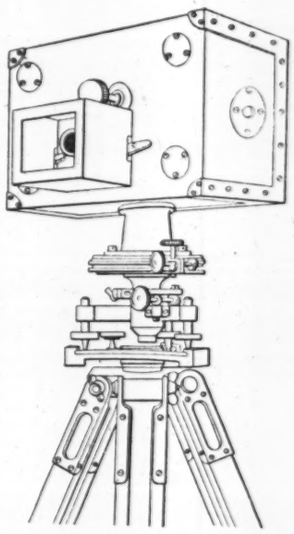

Fig. 3. Normal Position.

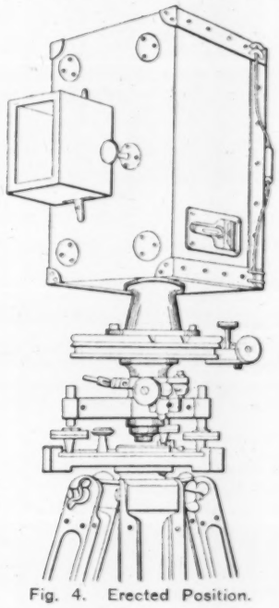

Fig. 4. Erected Position.

FIGS. 3 AND 4. CAMERA MOUNTED ON BASE OF PHOTO-TOPOGRAPHIC INSTRUMENT.

EFFECT OF VIBRATION AND LOAD ON STEEL.—An interesting note on this classic point of doubt occurs in the course of a paper "Erosion and Ballistics," by Prof. P. R. Alger, U. S. Navy, reprinted in "Journal of the United States Artillery," March, 1911, from "United States Naval Institute Proceedings," Dec., 1910. Prof. Alger says:

In 1883, or thereabouts, when Capt. Sicard, then Chief of the Bureau of Ordnance, proposed to build wire-wound guns for the Navy, a test of this theory [that guns are weakened by the shock and vibration of repeated firing] was made at the Washington Navy Yard as follows: Heavy weights, sufficient to strain the wire nearly to its elastic limit, were suspended by pieces of the wire intended for use on the guns, and small hammers were arranged so that, actuated by the machinery of the shop, they struck the taut wires at regular and frequent intervals. After months of constant vibration, all the time under severe strain, the wires, when tested, showed unchanged physical qualities. Moreover, every gun, army and navy, that has suffered accident, since we first began to build steel guns, has had the metal of the part that failed tested, and never has there been a case when any material difference was found between the physical qualities shown by the last tests and those shown by the original tests for acceptance. One of these guns, a 12-in., had been fired 481 rounds when its muzzle was blown off.

*The following notes were prepared by Mr. Thos. Riggs, Jr., Engineer to the Alaska Boundary Commission.

An Epidemic of Typhoid Fever at Lexington, Va., Evidently Caused by Leaks From Sewer to Water Mains.*

By ALLEN W. FREEMAN,† M. D., and RICHARD MESSER,‡ C. E.

The epidemic of typhoid fever occurring at Lexington, Va., in November, 1910, presented several features out of the ordinary and is reported for that reason. Lexington is a town of about 4,000 people, situated in the foothills of the Blue Ridge Mountains and noted chiefly for the two educational institutions located there, the Virginia Military Institute, with 350 students, and Washington and Lee University, with about 700 students.

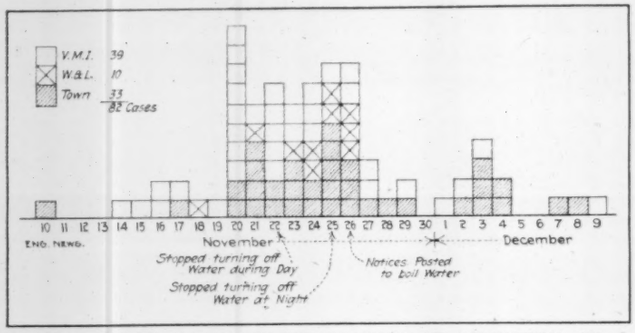
V.M.I. 39
W.&L. 10
Town 33
82 Cases
10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 1 2 3 4 5 6 7 8 9
ENG. NEWS.
November
December
Stopped turning off Water during Day
Stopped turning off Water at Night
Notices Posted to boil Water

FIG. 1. INCIDENCE OF TYPHOID CASES AT LEXINGTON, VA., DECEMBER AND NOVEMBER, 1910.

(The dates given are those on which patients took to bed. Records of four V.M.I. cases were not obtained.)

The district in which Lexington is located has long been heavily infected with typhoid. During the summer of 1910 there were ten cases of typhoid fever in the town, but all of these had recovered some weeks prior to the outbreak here reported. The epidemic began on Nov. 10, though the first case was not diagnosed until Nov. 18, when cases began to appear in the Virginia Military Institute. Fifteen cases appeared in the institute within two days, and the corps of cadets was furloughed and left for their homes on Nov. 20. The subsequent course of the epidemic is shown by the chronological chart herewith (Fig. 1). In addition to the cases charted, twelve additional cases were reported among the students of the Virginia Military Institute after their return home, the date of whose going to bed could not be obtained, making a total of 51 in that institution. Ten cases developed among the students of Washington and Lee University and 33 among the citizens of the town.

The distribution of the cases was peculiar, as may be seen from the map, Fig. 2. The Military Institute suffered out of all proportion, having an attack rate of one in seven of those exposed. The early cases were in the Institute and in the extreme eastern end of town, and the cases were practically all confined to that half of the town lying east of Nelson St. The cases occurring west of Nelson St. were all either students of Washington and Lee University, of one of the public schools located east of Nelson St. or persons working in the eastern end of the town. Those of the inhabitants living west of Nelson St. escaped the disease almost entirely.

A most careful investigation was made of all cases reported. Full epidemiological data were collected for each case and carefully studied and all facts which might have a bearing on the epidemic were taken into consideration in arriving at conclusions regarding the source of the epidemic.

All forms of food except water could be excluded on the epidemiological evidence. The cases were evenly distributed among the milk dealers of the town, and the milk supply of the Virginia Military Institute is furnished by a contractor who furnishes milk to no other persons. The strict military discipline at this institution and the fact that all cadets board at the mess hall of the Institute enabled the facts regarding food supplies to be determined with great accuracy. Ice cream, ice, shellfish and fresh vegetables could be positively excluded as sources of infection. Flies were not present at the time of the epidemic and contact or carriers could not have produced the disease. The town is almost completely sewered, and the disease could not have spread from open privies. A few of the citizens depend on water from private wells and springs, but these escaped the disease. The one factor common to all the cases was that they drank water from the public supply of the town. The investigators were early forced to the conclusion that water from this public supply was the cause of the outbreak. No other explanation seemed reasonable and all others could be excluded on the epidemiological evidence.

The question at once arose as to the uneven distribution of the cases, practically all being in half the town, and the very high attack rate among the students of the Institute as shown in the following table:

	Population exposed	Cases.	Attack rate.
Town of Lexington.....	3,000	33	1.1%
Washington and Lee University*	700	10	1.4%
Virginia Military Institute.....	350	51	14.5%

*The students of Washington and Lee, with the exception of a few who live in a dormitory, are scattered throughout the town in boarding-houses and private families.

This distribution being so different from that usually observed in water epidemics indicated either that the water theory as to the cause of the epidemic was erroneous, or that something out of the ordinary had taken place in connection with the water-supply. The evidence was reviewed repeatedly but no other conclusion was possible save that water was responsible for the epidemic.

A most careful inquiry was instituted as to the water-supply, which has been in use about 30 years. The town water-supply is derived from a series of springs located in two valleys, some three miles from town. The entire drainage areas of these valleys are owned by the town, and are free from obvious pollution of any kind. The water is piped direct from these springs into a collecting main, and thence to a receiving reservoir on the edge of the town. From the reservoir one main traverses the entire length of the town, following Main St. The drainage areas and springs were carefully inspected and found in excellent order, there being no signs of any pollution on the drainage areas. The geological formation is such as to lead to the conclusion that the springs, while arising in a limestone formation, are fed entirely from these protected drainage areas. The springs themselves were carefully enclosed and not open to surface pollution. In addition, the fact must be taken into consideration that there had been no rainfall whatever for several months prior to the outbreak. The inspection of the springs and drainage areas indicated that it was extremely improbable that the water could have been infected there.

The trunk sewer (Fig. 2) extends along Main St. parallel to the water main and at about the same elevation, the distance between the sewer and the main varying from 6 to 15 ft. No records were available showing the exact location of the sewer, and there were no manholes by which it could be determined. Evidence of careless and inefficient supervision of repairs and additions was disclosed by the fact that service pipes and sewer laterals have been found in the same trench close together. How often this method has been followed is not known.

The unusual circumstances surrounding the water-supply at this time were caused by the prolonged drought, which had lasted from May to the time of the outbreak in November. The drought was almost unprecedented, and all water-supplies of the neighborhood were exceedingly low.

Early in September, as the consumption had exceeded the supply for some days, and as the water in the reservoir was almost exhausted, it was decided to shut off the valve at the western end of town between the hours of 10 p. m. and 5 a. m., in order to accumulate some water in the reservoir for use in case of fire. When this upper valve was closed, the houses in the western portion of the town were deprived of water, which was gradually drawn out by those living in the lower portion, this effect usually extending as far east as Washington St. (see Fig. 2).

By the middle of October it was found that the heavy consumption by the large institutions at the east end of the town deprived the citizens of the west and higher portion of the town of water; and on Oct. 15 was begun the closing of the valve at Main and Henry Sts. between the hours of 9 and 11 a. m. and 2.30 and 5 p. m. The closing of the valve at Main and Henry Sts. maintained the pressure in the part of the town west of that point. The University, the Institute and the residences on Institute Hill were, however, immediately deprived of water by the closing of this valve, although the residences and the laundry on East Main St. could continue to draw water as long as any remained in the pipes.

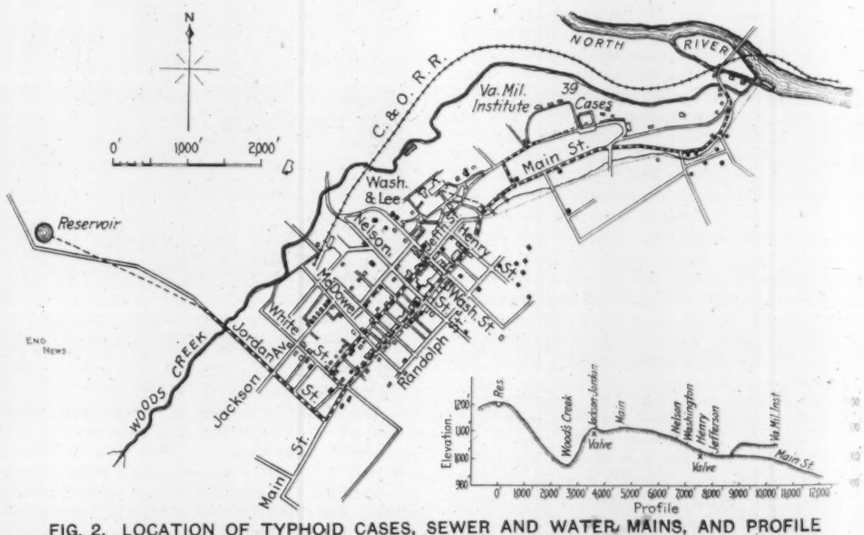

FIG. 2. LOCATION OF TYPHOID CASES, SEWER AND WATER MAINS, AND PROFILE OF WATER-SUPPLY MAIN, LEXINGTON, VA.

*The facts and conclusions given in this article are based on an investigation made by the authors for the State Health Department, and will be given in more detail in a forthcoming report.

†Assistant Commissioner and ‡Sanitary Engineer, respectively, of Virginia State Health Department, Richmond, Va.

During the month of October the surface of Main St. was being plowed up preparatory to resurfacing with macadam, and while this work was being done the opportunity was taken to make certain repairs and changes in fire plugs and service pipes along Main St. This work was executed principally between Oct. 20 and Nov. 9. During the course of this work, sometime between Nov. 5 and 8, the trunk sewer in Main St. was broken in one or two places, and during repairs at one point a considerable amount of sewage escaped into the excavation. At this point a service pipe had lately been laid connecting the main and crossing underneath the trunk sewer.

Conclusions.

A careful study of these conditions led the writer to these conclusions:

(1) The epidemic was caused by an infection of the public water-supply.

(2) The infection was most probably an infection of the water in the mains and not at the source of supply, and was brought about by the practice of shutting off certain parts of the system at various times.

The opinion usually held that infection of water in mains does not take place is based on the assumption of a positive pressure causing whatever leakage there be to pass from the water main to the soil or sewer. This, however, does not apply to the conditions existing at Lexington during November, 1910. When a portion of the supply system is shut off from the remainder, and when heavy drafts in one portion of this system exhaust the water from other portions, it may possibly give rise to even a negative pressure at certain points in the system.

Whether the infection of the mains took place through this means, or whether it was the result of the soiling of the mains with sewage during the repair work, or of some other means not recognized, cannot be determined absolutely.

The fact is positive that the water which reached and was consumed by the students at the Virginia Military Institute must have been infected to a far greater degree than that furnished to any other of the citizens of Lexington.

The Virginia Military Institute has been closed on two previous occasions because of outbreaks of typhoid fever: in the years 1899 and 1903. On both of these occasions the outbreak occurred in the month of October.

No report of the outbreak of 1899 is available, but after the above conclusions regarding the outbreak of 1910 had been written, the investigators came into possession of a copy of the report of Drs. Anderson and Perry of the U. S. Public Health and Marine-Hospital Service, who investigated the outbreak of 1903. The conclusions of these investigators bearing on this point are given herewith:

(1) That the general water-supply, at its source or reservoir, is not infected.

(2) That, on account of the leaks which have been reported in both the sewers and water mains on the same street, there is a strong probability of infection of the water-supply after it reaches the town.

(3) That the cases of fever are, in our opinion, due to localized infection of water and that the conveyance of infection by flies does not explain the rapid increase and wide distribution of the cases in the month of October.

Lack of Confirmatory Evidence.

The investigators realize fully the fact that the somewhat unusual conclusions expressed in this article are not supported by direct or laboratory evidence. Under the circumstances this evidence could not be obtained. The first care, once the evidence pointed to the water, was the remedy of conditions. The practice of shutting down the valves was discontinued on the first day of the investigation and before any samples could be collected for bacteriological examination. The experiment of turning off the water could not, of course, be performed under the circumstances.

It was at first hoped that confirmatory evidence might be gathered by digging up the mains where water and sewer pipe were together; but the evidence did not point directly to any one spot, and to uncover the whole main was of course out of the question. Some hesitancy was felt, also, in tampering with the mains under the existing circumstances.

The result of the remedial measures, which were adopted (a notice to the public to boil all water, and the discontinuance of the shutting off of the valves) was positive and came on the day calculated with almost mathematical accuracy.

Diesel Engines for Ship Propulsion: European Developments.*

Within the past few months a good deal has happened on the Continent with reference to the employment of the Diesel engine for marine work, and it seems probable that the next twelve months will be momentous in the history of marine engineering, since within that period several large ships equipped with such engines will be in operation, and working results will be available. In a recent visit to the Continent and a conversation with Dr. Diesel at Munich, the writer was able to obtain a good deal of information as to the developments now taking place.

The Problem of Reversing.

Powerful Diesel engines for land work have, of course, been in operation for several years, and the chief point which has prevented their use on ships has been the trouble in designing a satisfactory reversing engine. Though up to 1910 the four-stroke engine was the only type employed, it is probable that two-stroke engines will, in the future, be exclusively employed for marine work, though in them an extra cylinder for clearing out the exhaust gases from the working cylinders is in general required.

The fuel inlet valves are operated by cams in the usual manner, provided with two projections at 90°, and the reversing is accomplished by altering the position of these cams on the same shaft relative to the stroke of the levers operating the valves. The whole motion is controlled by one handle or wheel at the front of the engine, provided with an interlocking device to prevent the cams from being changed for reverse until the lever controlling the admission of fuel is brought back to the "stop" position, i. e., until all fuel and compressed air is shut off.

For the exhaust gases, slot valves are employed instead of the ordinary type. For lightness the main castings for the cylinders and bedplates are frequently but not invariably made of steel, contrary to land practice, where they are of cast-iron. The speeds for which the marine engines are designed are rather higher than with the ordinary slow-speed, four-stroke type, but lower than with the high-speed Diesel engine which is now finding favor for dynamo driving.

In Germany and France.

Almost the first large boat to be equipped with Diesel engines was the Romagna, built by the Cantieri Navali Riuniti at Ancona, and launched a short time ago. She is equipped with two four-cylinder, two-cycle, single-acting engines, each of 400 B.HP., and making 230 r. p. m. at top speed, which were constructed by Messrs. Sulzer Brothers, of Zurich. In Germany, as is well known, the Hamburg-American Line are having a twin-screw boat of 9,000 tons built by Messrs. Blohm & Voss, which is to be provided with Diesel engines of 3,000 B. HP., built by the same firm, running at 150 r. p. m. for a speed of 12½ knots. They are of the three-cylinder, two-cycle, double-acting type.

It is practically unknown in this country that there are now being constructed in Germany two Diesel engines, each of 6,000 HP., for a twin-screw vessel for the German Navy. The engines are each six-cylinder machines, which means 1,000 HP. per cylinder, showing what rapid advances are being made in this respect. But perhaps an even more important step is being taken in France, where there is now in hand a new type of war vessel, a combination of torpedo-boat destroyer and submarine, which is to be equipped with two Diesel engines with a total power of 4,800 HP.

In Belgium and Holland.

Messrs. Carels Frères, of Ghent, were among the first to construct a successful reversible Diesel engine, and they have now built and have on order several of large size. Two of 1,000 HP. have been constructed for a boat built by the Creusot firm, and these underwent prolonged trials before being accepted. They have a maximum speed of 250 r. p. m., and reversing is accomplished so satisfactorily that to change from full speed ahead to full speed astern requires only about half a minute, comparing very favorably with steam engines of the same power.

In Holland the Dutch East Asia Line has on order a twin-screw cargo boat, to be propelled by Diesel engines of 1,500 B. HP., while the Nederlandsche Fabriek van Werktuigen en Spoorweg-Materieel of Amsterdam, after having built Diesel marine motors of small size for some time, have constructed a 500-HP. engine, which has been installed on the oil-carrying tank vessel "Vulcanus." Her engines are of the usual four-stroke, single-acting type, with six cylinders 400 mm. diameter by 600 mm. stroke, and are in reality nothing more than a multiplication of the 80-HP., single-cylinder engine, of which so much experience has already been gained. The reversing is effected by means of two separate cam shafts, one for ahead and the other for astern, which are operated as desired through a main shaft by means of spur wheels, so that by means of a lever either cam shaft can be put in gear with the main shaft.

It must be admitted that this installation does not cope with the chief difficulties which have to be overcome before very large Diesel engines are possible for marine work. In the first place, a four-cycle, single-stroke engine is very large and heavy (this 500 HP. machine weighs nearly 50 tons), and large powers in single cylinders can only be obtained in the two-cycle, two-stroke type. These involve difficulty in getting rid of the exhaust gases, with special types of exhaust valves and the employment of scavenging cylinders or similar means. Further, there is the important point of cooling the pistons; this in the "Vulcanus" is accomplished by air circulation, which is hardly likely to be satisfactory on a larger scale; Messrs. Blohm & Voss will use oil for this purpose in the boat they are building.

It is doubtful moreover whether the range of speed on this engine would be at all suitable on a larger scale, since under ordinary conditions it is only between 70 and 160 r. p. m., though Messrs. Carels seem to have been more successful in their two-stroke engine. Messrs. Cockerill, who are now engaged in perfecting a type of Diesel engine for marine work, are tackling this problem by employing an engine with six cylinders in two sets of three, which may be run together or separately by means of a friction clutch. Slow speed is provided for by having three cylinders arranged to drive an air compressor that delivers air to the remaining cylinders, coupled to the propeller shaft, which thus run as air motors.

In England.

At the present time, no large English vessel has been equipped with Diesel oil engines, but it is now announced that Lord Furness has placed with Messrs. Richardsons, Westgarth & Co. an order for a set of single-screw Diesel engines of 1,000 HP. for a 3,200-ton ship, which is to be built for him by Sir Raylton Dixon & Co., of Middlesbrough. The engines will be of the slow-running open type designed by Mr. Westgarth, and it is intended to have the ship ready for sea in the autumn. Messrs. Swan, Hunter, and Wigham Richardson, as has already been announced, have built a cargo vessel for service on the American lakes to be propelled by Diesel engines, and Messrs. Barclay, Curle & Co. have on order a 5,000-ton vessel of the mixed type.

It may be taken that a two-cycle, double-acting Diesel engine of 1,000 HP. per cylinder is now an accomplished fact, and hence it is hardly an exaggeration to say that a power of 30,000 HP. is at the present moment a possibility for a Diesel engine installation on a ship, though this must not be anticipated till smaller vessels have passed through strenuous trials for endurance and trustworthiness. For small cargo vessels the future is more than hopeful, since it may be expected that the cost of Diesel engines will drop considerably in the near future, and the present disadvantage of greater first cost than for a steam plant will be eliminated.

*From the communication of "an engineering correspondent" in the "Engineering Supplement" of the London "Times" of April 5, 1911.

A SUSPENSION BRIDGE FAILURE IN INDIA AND ITS CAUSE.—The original bridge over Tolly's Nullah at Hastings was an elegant suspension structure consisting of a central span, with half spans on either side carried by the back chains; it was built by the Military Works Department in the early part of last century. It collapsed one very cold morning before the break of day, when there was no traffic on it. All the broken links of the chains showed a bright crystalline fracture. This was attributed to molecular alteration of structure owing to long continued vibration, an explanation that was considered quite satisfactory, and there would have been an end of the matter; but Colonel Hyde, R. E., at that time Master of the Calcutta Mint, was puzzled why the failure should have occurred when the bridge was sustaining no live load, and consulted me about it.

Upon investigation I found that instead of 9 to 12 ins., as originally intended, the road metal on the bridge had been gradually increased by the Executive Engineer under standing instructions for periodic repairs, until it amounted to over 2 ft. in thickness. The suspension rods, buried in this mass of road metal, had gradually corroded until they were no longer strong enough to sustain the excessive load of the metalling, contraction due to low temperature had resulted in the failure of the weakest or most overstrained of the suspension rods; that doubled the load on its neighbors, so that all the suspension rods on one side of the longitudinal axis snapped one after the other, and that side of the platform suddenly dropped and dumped its road metal into the Nullah. The side spans did not sustain any fracture, but they dropped, and their weight, with the excessive thickness of road metal, dragged the chains of the center span over the saddles of the towers—in flying over these the links were broken by side concussion, which accounted for the crystalline fracture.

I had several pieces cut from the broken links and tested them to destruction under tensile strain, they stood a high elastic and breaking strain, with extraordinary elongation and reduction of area, and showed a beautiful fibrous silky fracture, proving the metal to be of excellent quality and quite unimpaired by long service.—From "Reminiscences" by Sir Bradford Leslie, in "Indian and Eastern Engineer" for March.

Impact Tests on a Reinforced-Concrete Trestle; C., M. & St. P. Ry.

By J. H. PRIOR.*

Some tests to determine the amount of impact on a trestle of reinforced-concrete under train loads have recently been completed by the Engineering Department of the Chicago, Milwaukee & St. Paul Ry., under the direction of Mr. C. F. Loweth, M. Am. Soc. C. E., Chief Engineer. The tests were made on the reinforced-concrete trestle shown in Figs. 1 and 2, by Mr. R. L. Stevens, assisted by an instructor from the University of Wisconsin, experienced in such work.

Fig. 2 shows the trestle to consist of two beams (A), supporting the slab (B), forming a double T-beam. The total depth of this beam is 3 ft. 6 ins., but if the parapets are considered as part of the beam this depth is increased to 5 ft. 4 ins. As the span is only 16 ft. c. to c. of piers, the concrete beam has a large ratio of depth to span. Some unexpected difficulties were encountered in this work, due to this ratio of depth to span, and also to the fact that the girders are practically continuous over the supports.

The information mostly sought in these tests was the unit stress in the steel due to the total load on the structure including impact, as this information is of fundamental importance in the design of similar structures. On account of the great depth of span compared with its length, and the partial continuity of the beam over the supports, which had been only partly relied upon in the design, the unit stresses in the steel were low and the consequent distortions were so small that errors of the smallest magnitude affected the results by large percentages. On account of this, the results as a whole are somewhat unsatisfactory, but are thought worthy of publication in order to mark out a little progress in the subject and to save others from traversing the same ground. Table I. gives most of the important results of the tests.

The following is a description of the manner in which these results were obtained. The test train, shown in Fig. 1, consisted of the railway company's class A-2 engine (4-4-2) one gondola car loaded with sand, and a caboose. The trestle spans were designed for Cooper's E-50 loading, but the above train was equivalent only to about E-35 loading. An engine of class A-2 was selected because in this type, which is a four-cylinder compound, the unbalanced weights on the drivers are rather excessive and were expected to produce greater impact than other classes of locomotives. A marker was placed on one driver so that the location of the counterweight might be determined for the various runs.

The four extensometers and the deflectometer used in the tests were loaned by the University of Wisconsin. The tests were conducted in a manner similar to those made by the American Railway Engineering Association.† The four extensometers were attached to the bars which had been built into the girder so as to project a short distance, as shown in Fig. 1. One extensometer was located on the side of each girder. The projecting bars are located in the same plane as the lowest reinforcing steel in the girders, so that the deformations measured were the actual deformations of the steel reinforcement.

The deflectometer was attached near the center of one of the girders. The deflections were so slight, however, that no records of any value were obtained from this instrument. Consequently no results from it are mentioned in this report.

In Fig. 3 are shown some full-size diagrams obtained from the extensometer. The "measured ordinates," which are shown in column 2 of Table II., were obtained from these diagrams by scaling on the diagram the distance between the curve and a base line drawn to connect the zero stress ends of the curves. An examination of these diagrams shows the presence of some lost motion, due either to the projecting bar, or the imperfection of the extensometer. On account of the small amount of the distortions this lost motion, if not corrected, would introduce a substantial error. The amount of this lost motion was determined as follows.

A theoretical investigation of the properties of the section of the spans tested, comprising the girders, floor slab and parapet, showed that if all were assumed to act together, the section has a resisting moment in inch-pounds of 1,081 times the unit stress in the steel in the lower portion of the beam. For the test train this resisting moment gives a unit stress due to live load only in the reinforcing steel of but 680 lbs. per sq. in., and 103 lbs. per sq. in. tension in the concrete at the top of the parapet wall over the piers. These low stresses throughout cause only small distortions in the steel and give small ordinates in the extensometer diagrams.

For the E-50 loading, including impact and dead load, the stresses at the same points are 2,310 lbs. in the steel and 344 lbs. in the concrete. Since this bridge has never been loaded to quite this amount, it seems justifiable to assume that there are extensive regions in which the concrete on the tension side has never been ruptured, and that in the remaining portions the elongation of the steel is sufficiently restrained by the surrounding concrete to justify the assumption that the entire section acts effectively to resist distortion due to bending.

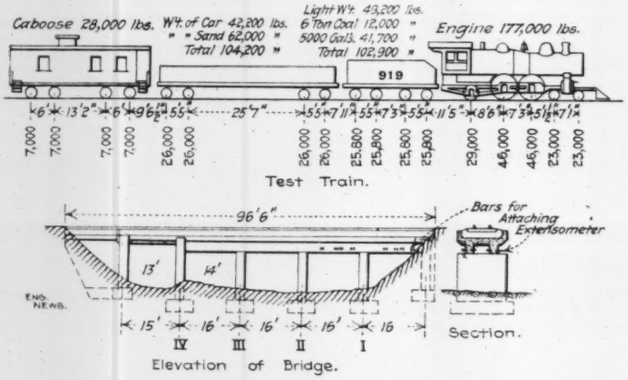

FIG. 1. TEST TRAIN AND REINFORCED-CONCRETE BRIDGE TESTED FOR IMPACT; C., M. & ST. P. RY.

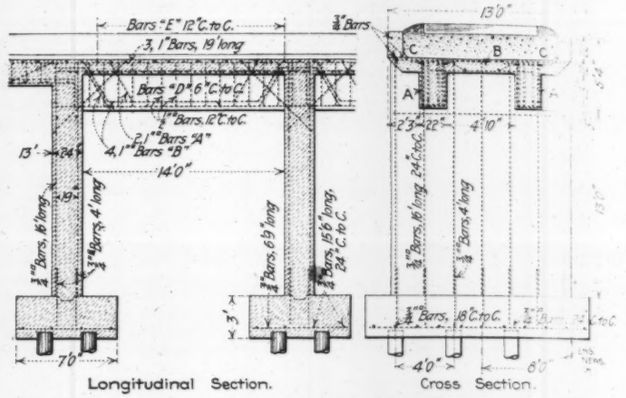

FIG. 2. DETAILS OF REINFORCED-CONCRETE BRIDGE SUBJECTED TO IMPACT TESTS.

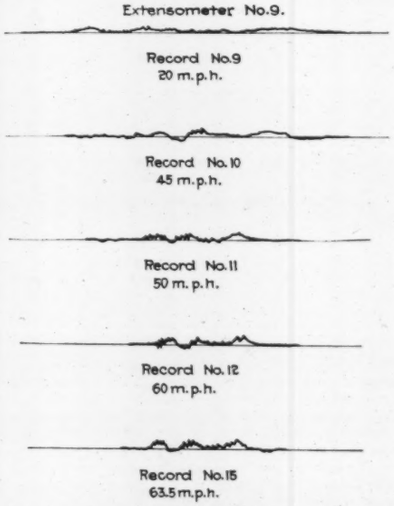

Fig. 3. Diagrams Drawn by Extensometer Under Impact Tests. (Full size.)

Using the above assumptions, there is shown in columns 4 and 5 of Table III. the calculated stress in the steel for the test train with its corresponding ordinates. These ordinates were assumed to be correct for static loads.

It is reasonable to assume that the error of lost motion mentioned is a constant, and that it affects all of the "measured ordinates" in column 2, Table II., by the same amount. If these ordinates contain a constant error, this error will be eliminated whenever we are considering the differences between two "measured ordinates." Now it is known that for speeds of 8 m. p. h. the impact is practically nothing, and that the difference between the "measured ordinates" for 8 m. p. h. and that for 20 m. p. h. gives the increase in ordinate due to impact at 20 m. p. h. The difference between these two "measured ordinates" for a speed of 20 m. p. h. in Table II. is 0.012-in. This difference divided by the total calculated ordinate for instrument No. 9 in column 5, Table III., is 0.2, which if our assumptions are right would show an impact of 20% for a speed of 20 m. p. h.

The value of 20% just calculated was obtained from a reading of only one instrument, extensometer No. 9. The records of two other instruments not shown give values of 15% and 18%. The values given by the fourth instrument are divergent, but can be accounted for by the irregular character of the quantity measured. Of these values, an impact of 15% was selected because it agrees in a reasonable way with the values obtained for a speed of 20 m. p. h. in a large number of experiments on steel structures.* When the impact for 20 m. p. h. has been determined, it is an easy matter to make an approximation of the lost motion and to correct the "measured ordinate" by the calculated lost motion, so as to obtain the values in column 3 of Table II., called "corrected ordinate." This "corrected ordinate" is obtained by the following equation, in which, in the first member of the equation a is the "corrected ordinate," and where values in the second member of the

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†Bulletin No. 125 (July, 1910); American Railway Engineering Association, Chicago.

*Bulletin No. 125, American Railway Engineering Association (previously noted).

equation are the first, second and sixth items in column 2 of Table II.

$$115\%a - 100\%a = \tfrac{1}{2}\,(.024 \pm .022) - .12.$$

$$15\%a = .011.$$

$$a = .073.$$

From the above we get "calculated ordinate" for speed of 8 m. p. h. 0.073. The "measured ordinate" for that speed is 0.012, in column 2 of Table I. Their difference is the constant error, .073 — .012 = 0.061. If the constant error thus determined is added to the "measured ordinates" in column 2, Table II., we obtain column 3, Table II., marked "corrected ordinate."

The difference between these "corrected ordinates" and the "corrected static," column 4 of Table II., is the "excess over static" in column 5. The values in column 5 divided by the values in column 4 give the percentage of impact in column 6.

Column 2 of Table II. is column 2 of Table I. The other columns of the summary of results in Table I. were obtained in the same manner from tables similar to Table II., but not shown in this report. The "corrected static" ordinates for the extensometers Nos. 10, 11 and 12, obtained in a similar manner to those for extensometer No. 9 in Table II., are shown in column 6 of Table III., where they are compared with the calculated ordinate shown on column 5 of the same table. Considering the small quantities involved the agreement is fair and seems to justify the assumptions made.

Incidentally, Table III. shows that the structure does not receive anything like the stresses for which it was designed. The longitudinal joint C (Fig. 2) between the slab and the parapet wall, which it was thought inadvisable to count in the design for transmitting longitudinal shear, seems to be entirely effective for that purpose, making the entire span a monolith. This suggests that possibly the design of the parapet walls of similar slabs might be modified so that there might be no doubt as to the ability to carry the stresses, which they unquestionably receive.

It does not seem that the location of the counterweight in its lowest position with regard to the center of the span influenced particularly the amount of impact obtained. However, as the structure consists of five spans fully continuous and integral with the piers, it is hardly expected that the effect of the counterweights would be as clearly defined as in simple spans, although the unbalanced weights may be just as effective in producing impact, especially if the span had been the ordinary shallow slab, not built in place.

As shown in Table I., the maximum impact obtained under the engine was between 50 and 60%, although the number of observations made was hardly sufficient to warrant the conclusions that no higher values might be expected.

As a fund of definite information on this subject is of economic value in the design of reinforced-concrete structures, the subject seems to be worthy of further study and investigation, and Mr. Loweth has at present in mind some further tests to be made on shallower and longer spans.

TABLE I.—SUMMARY OF RESULTS OF IMPACT TESTS.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Extensometer No. 9		Extensometer No. 10		Extensometer No. 11		Extensometer No. 12	
Speed, m.p.h.	Engine	Car	Engine	Car	Engine	Car	Engine	Car
	Percentage of Impact							
8	..	..	..	..	..	..	..	..
20	16	41	14	25	15	54	18	32
45	16	32	14	31	18	24	20	21
50	33	32	36	40	33	24	45	27
60	41	38	46	31	42	39	54	27
21	14	29	19	..	15	42	12	18
63.5	38	46	27	87	18	30	33	18

TABLE II.—ORDINATES AND IMPACT FOR EXTENSOMETER NO. 9.

(1)	(2)	(3)	(4)	(5)	(6)
	Length of Ordinates				
Speed, m.p.h.	Measured, ins.	Corrected, ins.	Corrected static, ins.	Excess over static, ins.	Excess impact, Per ct.
8	0.012	0.073	0.073	0.000	..
20	0.024	0.085	0.073	0.012	16
45	0.024	0.085	0.073	0.012	16
50	0.036	0.097	0.073	0.024	33
60	0.042	0.103	0.073	0.030	41
21	0.022	0.083	0.073	0.010	14
63.5	0.040	0.101	0.073	0.028	38

TABLE III.—RESULTS FOR EXTENSOMETER NO. 9.

	Extensometer.		Calculated Ordinates		Static Ordinates	
(1)	(2)	(3)	(4)	(5)	"Corrected" (6)	(7)
No. Extens.	Lever. ratio.	Length of rod, ft.	Stress, lbs.	Ordinate, in.	Ordinate, in.	Stress, lbs.
9	47.0	4.38	680	0.059	0.073	840
10	47.2	4.40	680	0.059	0.073	840
11	52.5	4.35	680	0.066	0.067	690
12	48.5	4.25	680	0.001	0.133	1,480

Specifications for Wood-Block Paving.

By S. WHINERY,* M. Am. Soc. C. E.

The official printed report of the Proceedings of the Association for Standardizing Paving Specifications, at its second meeting in New York, Jan. 10 to 14, 1911, is now available to the public and the specifications adopted may be intelligently discussed.†

The specifications for creosoted wood-block pavement adopted at the first (Chicago) meeting were readopted at this meeting with a few changes. The changes made tend to lower the standard of requirements and seem to be in the nature of concessions to the views or the demands of contractors. To many engineers who have given some attention to street paving these specifications seem to be open to severe adverse criticism.

The requirements for the timber to be used read as follows:

> Yellow pine blocks shall be made from what is known as Southern yellow pine, well manufactured, full size, saw-butted, all square edged, and shall be free from the following defects: unsound, loose and hollow knots, worm holes and knot holes, through shakes and round shakes that show on the surface. In yellow pine timber the annual rings shall average not less than eight to the inch and shall in no case be less than four to the inch, measured radially.

The phrase "What is known as Southern yellow pine" presumably means the lumber sold in the market under that general name, but whether so intended or not, contractors will be fully warranted in contending for that meaning. The text contains nothing to define or to modify this commercial definition except some stipulations as to certain defects from which the lumber must be free, and the requirement that "The annual rings shall average not less than eight to the inch, and shall in no case be less than four to the inch." While the classification adopted by the Yellow Pine Association of the South divides yellow pine lumber into several classes or grades, these specifications do not even state to which of these grades the lumber shall conform.

It is well known that Southern yellow pine lumber, as it is offered in the markets, is made up of timber from practically every species of pine found in the Southern states, of both mature and second growth. Some of these species, and second-growth timber of all of them, produce lumber distinctly inferior in strength and durability, as a paving material, even after preservative treatment.

The present specification seems to be framed upon the assumption that any species of Southern pine, whether of mature or second growth, is good enough for paving blocks, and will be admitted for use. This conclusion is confirmed by the stipulation regarding annual growth rings. Any cargo of Southern pine found in the market will easily conform to the requirement that the annual rings shall average not less than eight to the inch and shall in no case be less than four to the inch. It has been said that this stipulation was intended to apply to individual blocks, and not to the blocks considered *en masse*, but if that was the intention the framers of the specification were singularly unfortunate in the language adopted. Briefly, the present specification will admit anything commercially recognized as Southern pine, provided it be free from the defects mentioned; and among the defects named, that of incipient decay, known as "dotiness," does not appear. This is, perhaps, the most common as well as the most serious defect found in Southern pine lumber. The only mention of unsoundness is in connection with and relates to unsound knots.

The specifications name Black Gum as one of the species of timber that may be used. The writer has several times publicly called attention to the fact that two distinct species of trees are commonly called black gum. One is the true black gum (Nyssa silvatica) and the other (Nyssa aquatica) is more frequently called Tupelo gum. The latter is a very inferior wood and its use for paving blocks should be prohibited. Whether so intended or not by the framers of this specification, contractors may reasonably claim the right to use this Tupelo gum in their paving work. If it was the intention to exclude this wood the specifications should have so stated.

The indiscriminate use in the same pavement of blocks made from all species and qualities of Southern pine is very objectionable. Some of these blocks will wear down more rapidly than their neighbors, resulting in an uneven surface and earlier failure of the pavement. While a clause in the first paragraph quoted above stipulates that only one kind of wood shall be used in any one contract it could not be successfully contended that this would authorize the engineer to compel the contractor to separate the several species of Southern pine from each other, since the obvious meaning of the clause is to consider Southern yellow pine as one kind of wood only. If it was intended to be construed otherwise, then the different kinds of pine should have been separately named. One of the important requisites for a satisfactory wood block pavement is that it shall wear down uniformly, and shall thus retain a uniform surface. Observations of the older wood pavements show conclusively that blocks of inferior or second-growth pine wear down most rapidly and where these are mixed indiscriminately with blocks of superior wood the result, in time, is an uneven and unsatisfactory surface. If, therefore, short-leaf and second-growth pine is to be admitted there should be some provision that blocks of different wearing qualities should be separated and laid together.

Preservative Treatment.

The specifications adopted at the first meeting of the association, defining the character and quality of the oil to be used for treating the paving blocks, were practically readopted at the last meeting.

They call for a coal tar product, free from adulteration of any kind, having a specific gravity not less than 1.10 nor more than 1.14 at a temperature of 38° C. Not more than 3½% of this oil shall be insoluble by hot, continuous extraction with benzol and chloroform. Upon distillation the distillate shall not exceed 2% up to 150° C., and shall not be less than 30 nor more than 40% up to 315° C.

The committee reporting these specifications refers in its report to the above material as creosote oil. It is not creosote oil at all, and this fact should be kept in mind and emphasized. The specific gravity named and the distillation test prescribed would, either of them, exclude any oil that has heretofore been recognized by engineers, chemists and recognized authorities on the subject as creosote oil. Wood treated with the coal-tar product described is not creosoted wood. In the experimental stage of this method of treating paving blocks city officials and citizens should not be led to believe that they are getting *creosoted* wood paving blocks. The material should be clearly differentiated and compelled to stand on its own merits, and if it shall prove to be superior to creosote oil, as claimed in the report of the committee, it should have full credit under a proper distinctive name.

The fact should be fully and generally understood that as a wood preservative this oil is a comparatively new and untried product. The committee in its report says:

> The Committee is satisfied, from the testimony of the different parties examined, and from the experience of its own members, that the oil with a specific gravity of 1.10 is best suited for treating wood blocks, when it is considered that a waterproofing as well as a preservative compound is desired.

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[†John B. Hittell, Secy.-Treas., 5917 Winthrop Ave., Chicago, Ill. The report may be obtained by non-members by payment of $5 per copy.—Ed.]

It would be interesting to know the names of the different parties examined, and the facts developed in their testimony. Also to have a more detailed statement of the experience of the members of the Committee leading them to the above conclusion; and particularly to know over how many years their experience in the use of this material has extended.

If experience in the matter of wood preservatives has taught us anything it is that a thorough trial, extending over a period of from 15 to 20 years, is necessary to determine the merit of proposed new materials and processes.

During the past half century a large number of these wood-preserving materials and methods have been announced and promoted, with blaring trumpets, as equal or superior to creosoting, and more economical. How many of them have survived the test of time and experience?

The consensus of opinion among the great majority of experienced engineers to-day is to the effect that treatment with true creosote oil is the only process of wood preservation that has satisfactorily stood the test of actual use. Various experiments are still being tried and various confident opinions are held as to their probable success; but there are not many who will not concede that time and thorough trial are necessary to establish the merit of any of these new processes.

It is claimed for this specified oil that it contains the same antiseptic elements as creosote oil in a sufficient quantity to insure the destruction, or to prevent the growth, of the organisms that cause the decay of wood. This may prove to be true; but inasmuch as we do not yet know definitely what these particular elements are, how can any one be certain of that fact? What we do know is that true, high-quality creosote oil does contain them, and will absolutely prevent the development and growth of the destructive organisms.

Is it wise then to discard this old and tried preservative for a new and comparatively untried one?

The reasons given in the Committee report for specifying this new oil are:

First: That the material is not controlled by a monopoly, as has been charged.

In regard to this the statement made by the committee is very cautious and unsatisfactory.

> The Committee examined very carefully into this question, having before it manufacturers of creosoted wood blocks from different parts of the country, and also several technical experts not affiliated with any contractor or corporation.
>
> The committee has found that the oil specified may not only be produced in the open market at reasonable cost, but, also, may be manufactured by any one competent and willing to erect the necessary plant, and this plant, moreover, would not be prohibitive from a financial standpoint.

Had the committee been able to report: we investigated this question thoroughly and have satisfactory evidence that the oil specified is manufactured and offered for sale by a number of responsible and wholly independent concerns, having no connection with each other, engineers and the public would have accepted the statement as conclusive.

However, the question whether the material is manufactured and sold by only a single corporation or combination is not important, provided that it can be procured by any contractor in any quantity needed at a reasonable price, uniform to all contractors alike. While the Committee does not say so, it is understood that it had assurances from the parties manufacturing this oil, that it is prepared to and will comply with these conditions.

The price is not named in the report, but some light is thrown on this point in the report to the City Council of Chicago by the delegates to the meeting, among whom was the Secretary of the Association, where it is stated that "The difference in price of ½-ct. per gal. is not sufficient to take into consideration, especially with the other decided advantages of the 1.10 oil," from which we understand that the oil specified is understood to cost about ½-ct. per gal. more than genuine creosote oil. This, if the blocks are 3½ ins. deep and impregnated with 20 lbs. of oil per cu. ft., would be equal to about 3¼ cts. per sq. yd. of pavement. This slight increase in price is, as stated, of little importance if the material were really superior to creosote oil.

Second: The Committee reports that it

> is satisfied that the oil with a specific gravity of 1.10 is best suited for treating wood blocks, when it is considered that a waterproofing as well as a preservative compound is required.

It is here assumed first, that waterproofing is necessary, and second that the oil specified is superior in waterproofing qualities to creosote oil; also, by inference, that it is at least equal to creosote oil as a wood preservative. Let us examine these assumptions.

It is known that where wood is treated with creosote oil some of the more volatile elements may evaporate and that on exposure to water a portion of the oil is washed or leached out of the wood. There is, however, plenty of evidence that if the proper quality of creosote oil is used and the work of impregnation is properly done these defects are negligible. In the early eighties a very long railroad trestle was built across Lake Pontchartrain, near New Orleans. The piles and other timber were well treated with high-grade, genuine creosote oil. This trestle has endured for nearly thirty years and at last accounts is still in excellent condition. The piles have been exposed, at the water surface, to constant saturation and to the washing of water as the tide rises and falls. Similar examples of long life and endurance are quite plentiful along the gulf coast. Paving blocks are never subjected to conditions of equal severity, and it will hardly be contended that a preservative with such a record is likely to fail prematurely, when applied to pavements, from evaporation and washing out of the oil. We are not, however, compelled to rely wholly on experience gained from the use of creosote oil in structures other than pavement. Instances in this country, not to speak of foreign cities, may be cited where creosoted wood-block pavement has endured at least fifteen years without signs of decay.

But it is urged that paving blocks must be guarded against the absorption of water and the consequent expansion of the wood, and that the new oil is peculiarly suited for this purpose. This is plausible in theory but weak in fact. It was in pursuance of this theory that many of our early creosoted wood-block pavements were treated with a mixture of true creosote oil and rosin. This treatment was almost ideal from the viewpoint that the blocks must be made impervious to water as well as preserved against decay. But experience shows that these blocks have not, in use, continued to be waterproof, nor have the pavements made from these blocks been free from occasional failure by expansion and buckling. If any one doubts that these blocks now absorb water freely let him take up some of them that have been in the streets for two or three years and test their capacity for absorbing water. Such a test, made by the writer, shows that there is but little difference between them and untreated blocks in the quantity of water they will absorb. If this be true—and the fact can easily be verified—it appears that the necessity for and the practicability of special measures for waterproof paving blocks has been greatly exaggerated. If a sufficient number of properly constructed expansion joints are provided the danger from bulging or buckling will be almost negligible, even if the blocks are untreated.

The most surprising and inexcusable thing about these specifications is that they absolutely exclude true creosote oil from use. Cities adopting them cannot utilize, in their wood paving, the only preservative that has stood the most severe tests of time and experience, even though it may cost less than the new and untried oil now called for.

The question to what extent the oil specified will prove satisfactory for the preservative treatment of paving blocks under all conditions can only be answered by experience extending over a sufficiently long period of years.

In the case of heavily-traveled streets where the pavement will be worn out in a comparatively few years, little protection against natural decay is needed, and almost any comparatively heavy oil or bitumen (such as water-gas [illegible]) will give satisfactory results. But in the [illegible] of streets carrying very light travel, [illegible] the blocks will not *wear out* for fifteen [illegible] twenty years, thorough preservative treatment [illegible] very essential, and good engineering judgment dictates that only preservatives that have been proved efficacious should be used. It would [illegible] be most unwise to use any comparatively new and untried preserving material or process [illegible] such streets.

The requirement that the oil shall not contain more than 3½% of matter insoluble in benzol and chloroform is, in the opinion of the writer, unnecessary, and will tend to restrict competition. This insoluble matter will presumably be largely fixed carbon, which is objectionable to the extent only that it obstructs the pores of the wood, and prevents proper penetration of the oil.

This question of the permissible quantity of fixed carbon in wood-preserving oils has recently been widely and in some cities very vigorously discussed. The writer is not inclined to attach much importance to the matter, and would allow the contractor considerable latitude. The important thing is that he shall get into the wood the stated quantity of oil per cubic foot, and he should be held strictly to this requirement. If he can accomplish this with oil having a high percentage of fixed carbon, but satisfactory in all other respects, there seems to be no valid objection to permitting him to do so.

In some other respects these specifications are indefinite, and lacking in that clear, full and specific description of the work required, that every specification should contain. For instance: "The blocks shall be laid on a sand cushion 1 in. in thickness placed upon the concrete foundation." It seems not to have been thought worth while to specify the quality of the sand to be used.

Regarding expansion joints it is said: "These joints to be filled with a bituminous composition," but there is no requirement as to the character and quality of the bituminous composition to be used, although this is an important consideration.

These and similar clauses were doubtless thus framed in outline only, so that each city engineer could expand and complete them to suit local conditions, or exercise his judgment in the matter of details. Inasmuch, however, as they purport to be standard specifications, expressing the judgment of the Association, and as some of the details omitted are of considerable importance, it would have been better to make them more full and definite.

SAND-LIME BRICK, building brick made by pressing together milk of lime with 10 or 12 times its volume of coarse sand, are being manufactured in this country in increasing numbers, as shown by the following extract from a recently published U. S. Geological Survey Bulletin, by Mr. Jefferson Middleton:

The sand-lime brick industry has developed rapidly in the United States. It began in 1901 at Michigan City, Ind., with one plant producing only a few thousand brick, which was followed shortly by a plant at Wilmington, N. C. In 1903 there were 16 plants in operation, which marketed a product valued at $155,040. From this small beginning the number of operating plants and the value of the product increased steadily until 1907, when 94 operating plants reported an output valued at $1,225,769. These figures are the highest yet recorded in the industry. In common with other industries, the value of sand-lime brick fell off considerably in 1908. In 1909, however, there was a small increase, and 1910 (not yet reported) bids fair to exceed the record of 1907. There appears to be no doubt that this industry is firmly established and will probably show a steady growth. The experimental stages have been passed, and although, as in all lines of endeavor, there will be individual failures, it is believed that the problems of the successful manufacture of sand-lime products of high grade have been solved and that with proper material and manipulation a good product can be made. Where material is abundant and the market satisfactory, especially if there be an absence or scarcity of other structural material, the sand-lime brick industry should prosper. This product has been subjected to many tests, both in the laboratory and in actual use, and seems to have met these tests in a generally satisfactory manner.

The tabulated statement of production is as follows:

Year.	Number of plants.	Value of product.
1903	16	$155,040
1904	57	401,128
1905	84	972,964
1906	87	1,179,405
1907	94	1,225,769
1908	87	1,029,960
1909	74	1,150,980

Field Construction of a 110,000-Volt Transmission Line.*

The accompanying figures show some of the various steps in the erection of one of the 110,000-volt transmission lines of the Hydro-Electric Power Commission of Ontario, the general features of which were noted in Engineering News, March 16, 1909, p. 301. It will be remembered that this line transmits power from the station of the Ontario Power Co., at Niagara

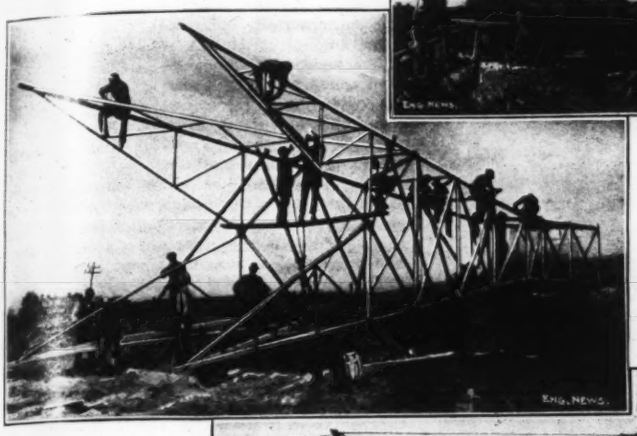

Fig. 1. Placing a Steel Grillage Foundation for Transmission Line Towers.

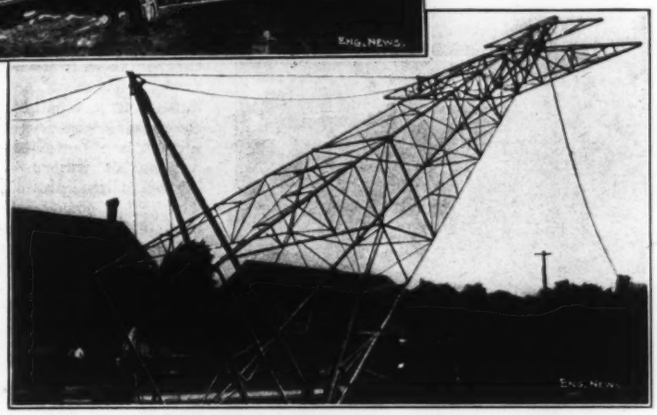

Fig. 2. Assembling a Steel Transmission Line Tower.

Falls to some 30 towns and cities in Ontario, as far west as London and St. Thomas. The lines have a total length of 293 miles, though the greatest distance of transmission is 139 miles. For the greater part there are six aluminum cables carried on steel towers spaced approximately 550 ft. apart. The cables are hung from the towers by suspension-type insulators. The towers are built up of angle-iron and are what is termed "windmill" type. The standard towers are 65 ft. high and weigh nearly two tons each. To ensure stability, solid foundations have to be provided, and for this purpose the four legs of each standard tower are bolted to angle-iron grillages or frames which are embedded about 8 ft. in the ground. In Fig. 1 the setting of one of these frames is shown. A special templet is used to hold the footings accurately in place while the holes are being back-filled and tamped. In some cases locations were found where water and quicksand were struck a few feet below the surface of the ground. In these cases wooden crib-

Fig. 3. Hoisting a Steel Transmission Line Tower Into Place.

bing or sheet piling was necessary in the course of the excavations. Excavations had to be made in solid rock for a few foundations and for others concrete footings were needed for protection against flood, ice, etc. However, the standard grillage frames proved entirely satisfactory in the great majority of cases where they could be used at all. About every tenth tower was of extra heavy construction. These were inserted in the line in this way for turning corners and to increase the stability.

The material for the towers was shipped in carload lots, one carload containing generally the material for ten towers. The materials were delivered along the line by teams. Fig. 2 shows a gang assembling an anchor tower near the Welland Canal. The work in these gangs was subdivided, each man having definite duties. Some did nothing but laying out the towers and putting the sides together on the ground; others raised these sides into position for the main body, and still others added the cross arms. Another division put on the finishing touches, tightened the bolts, etc.

FIG. 4. HOISTING A TRANSMISSION LINE TOWER UPHILL INTO PLACE.

In Fig. 3 is shown the commonly employed scheme to secure sufficient stiffness, while raising the towers in place. During this erection, temporary bottom braces were inserted between the tower legs. Block and rigging was arranged as shown, and a team was used to lift the tower. In many places the surroundings led to serious difficulties in this work. Such a condition is shown in Fig. 4, where the tower is being raised uphill.

As soon as the towers were in place, the insulators were hung in strings of eight disks, and the aluminum line cable was attached to the end of the string. At the anchor towers, strain insulators were used, the cables being pulled up tight, as shown in Fig. 5. Here two linemen are making the final loop connections around the strain insulator. In addition to the power cables, two ground wires of stranded steel were strung above the cables as protection against atmospheric discharges of electricity to the line.

*From information furnished by De Muralt & Co., Ann Arbor, Mich.

A HIGH-PRESSURE WATER-SUPPLY SYSTEM for fire protection in Boston is strongly advised in a report just made public by the Committee on Fire Prevention of the National Board of Fire Underwriters, 135 William St., New York City. In connection with the descriptions of similar systems elsewhere the report states that "high-pressure water mains used exclusively for fire protection" have already been installed in New York City (three systems altogether), Philadelphia, Cleveland, Detroit, Buffalo, Oakland, Cal., Toronto, Ont., and Winnipeg, Man. In addition, San Francisco and Baltimore are now putting in such systems, and Portland, Ore., and Toledo, Ohio, "have started them." The system in Philadelphia has been in use nearly eight years.

The present domestic water-supply in the congested value district of Boston is conceded to be entirely adequate for use under the present fire-engine system, but a suitably designed system for Boston would be able to deliver more water at high pressure than all of the steam fire engines now in service in the city operating at the same time.

The rated capacity of fire engines is misleading in considering their ability to deliver water under severe conditions. The tests of 347 steam fire engines during the past two years by the engineers of the National Board of Fire Underwriters, in 45 cities throughout the country, show that they deliver, on an average, 88% of their rated capacity, based on 100 lbs. net water pressure. The condition of operation at a serious fire usually requires higher pressure on account of the long lines of hose and heavy streams used, and fire engines under these conditions do not deliver more than 50% of their rated capacity for any length of time.

To sum up the advantages of the high-pressure fire system: A large number of powerful streams can be concentrated on a fire in much shorter time and with fewer men and less apparatus than with fire engines, and at the same time the protection of the rest of the city would not be weakened to the extent now necessary on third and fourth alarms from the district covered by the system. It will deliver its full capacity at any point in the district covered and at any desired pressure, and can sustain this pressure as long as wanted. It eliminates the confusion entailed in the operation of a large number of fire engines, tends to prevent the misunderstanding of orders and in every way simplifies operation. Above all, it provides protection to the congested value district even with a general alarm fire under headway in another part of the city and is the greatest insurance against conflagration, forming an effective barrier against fires starting outside the district, and affording the most efficient check of fires in the district which might otherwise involve a number of large blocks.

Practical experience has shown that the following requirements should be met in the design of a separate high-pressure fire system to insure good fire protection in districts it is to cover:

A fireproof pumping station, with all openings protected in an approved manner and removed from the zone of sweeping conflagrations. Station to be equipped with sufficient pumping units of moderate capacity to aggregate a total capacity of 20,000 gals. per min. at 300 lbs. pressure, taking suction from a fresh-water supply, preferably the Charles River Basin, and delivering into the gridiron system through well looped and gated discharge connections.

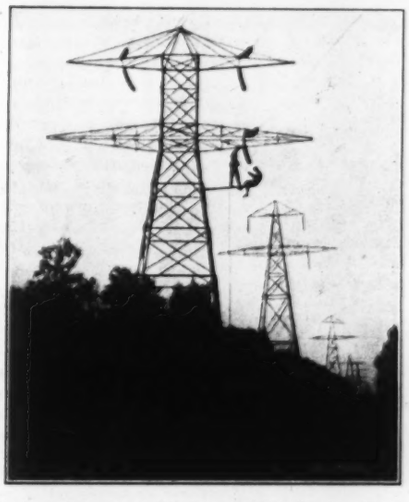

Fig. 5. Linemen at Work on a Steel Anchor Tower.

The distribution system to be connected with the pumping station through duplicate supply mains and to be so designed as to deliver the full capacity of 20,000 gals. per min. about any block within the area served, without excessive loss of head; to contain no pipes less than 12 ins. in diameter, no dead ends and be connected at all intersections. Connections to be provided to the system so that the fireboats may be used as auxiliary pumping stations in case of emergencies, and system to be provided with gate valves so placed that not more than 500 ft. of pipe will have to be cut out at one time.

Hydrants to be of ample dimensions, with four independently-gated hose outlets and connected to the mains through 8-in. gated connections; to be so distributed that the average area served by each shall not exceed 40,000 sq. ft.

A Timber Floor Construction for Reinforced-Concrete Factory Buildings.

By FRANCIS W. WILSON.*

Factory buildings of first-class "mill construction" have been considered for some years past as representing the highest development of factory construction, short of fireproof construction. The cost of absolutely fireproof buildings for factory purposes has been, and still remains, too great to warrant their construction except in isolated cases and for special manufacturing purposes where the fire risk is abnormal.

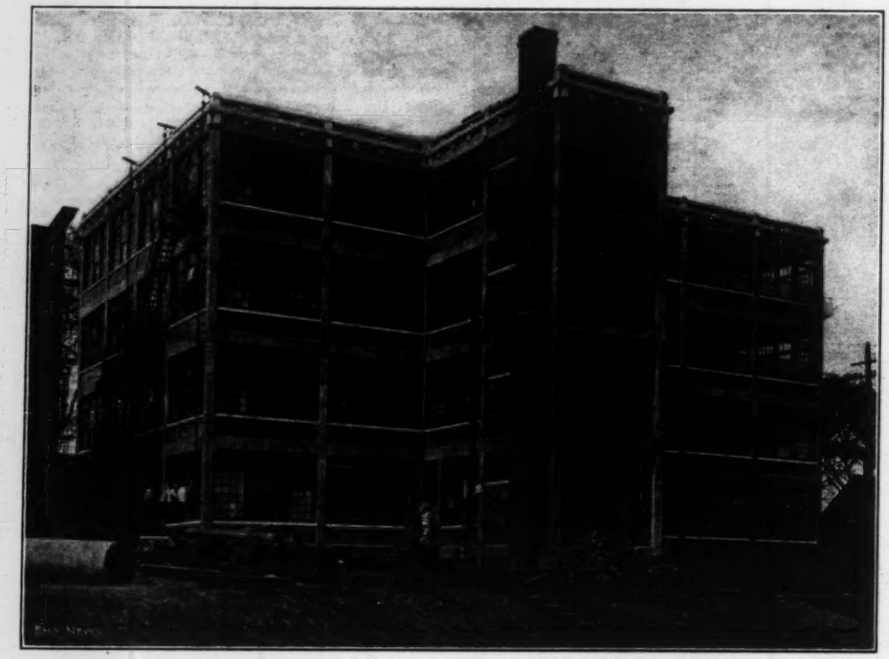

FIG. 1. VIEW OF REAR OF OFFICE BUILDING OF FORE RIVER SHIPBUILDING CO., QUINCY, MASS.
(Reinforced-concrete frame, brick walls, and timber floors.)

The ideals of good mill construction are well understood, but considerations of economy and the tendency of keen competition have resulted in greatly modifying and deteriorating this type of construction in many of its essential features. For example, the original idea was to use hard pine beams and posts, having an excess of strength over the actual requirements, with the idea that in case of fire the beams would char on the outside to a limited depth, and, after that occurred, would burn very slowly. In other words, it was proposed to use very large sizes of timbers, whether they were actually required for strength or not, and in this way provide some additional fire resistance.

It has become difficult to get hard pine of good quality and in the larger dimensions, and the cost has materially increased during recent years. The designers of mills and factories have competed with one another to the end of producing buildings at a lower cost than their competitors. The contractors, driven by competition, have been ready with their suggestions as to means of reducing the cost of construction. The owners have helped to induce both designers and contractors to cut down the quality of the construction, in many cases, by putting it up to both the designer and the contractor that if their buildings could be built for a given sum of money (always the minimum) they would proceed with construction; otherwise they would postpone the matter indefinitely. The result is that buildings of so-called "mill construction" are in many cases a wide departure from the original intent, and in very many cases the strength of the construction is barely adequate to the actual needs, if, in fact, it is able to meet them.

There are some mill architects who have not succumbed to the tendencies above referred to, and, in fact, their designs are in many respects an improvement over the original requirements of good "mill construction"; but it is interesting to note the cost of buildings when designed in this manner and constructed under modern conditions as to cost of labor and materials. Many such mills and factories cost more than the same building would cost if built entirely of reinforced concrete and made fireproof throughout.

Assuming the very best results possible to obtain in "mill construction" as regards design, materials and workmanship, there are even then some well-grounded objections to this type of construction for factory and mill buildings. For example, the matter of vibration. The floor beams, supported by brick walls and by "post caps," have no rigid attachment to either. The posts, put up in sections, often jointed by cast-iron pintles, have no material rigidity. The result is that vibration in buildings of this construction is inevitable.

To some manufacturers the matter of reasonable vibration may be unimportant, whereas in some lines of manufacturing any vibration at all is seriously detrimental and almost fatal to the production of a high-class product. A well-known mill architect, located in New England, told the writer that the reason why some classes of textile goods could be produced in better qualities in England was simply that the British mill buildings were more solidly constructed, and thus admitted less vibration than the cheaply constructed buildings used in the same industry in this country.

Aside from the question of vibration, there is another consideration of importance to manufacturers. There is a growing tendency on the part of manufacturers to want longer spans for the beams and girders, or, in other words, fewer interior posts. There is a very moderate limit in this direction if hard pine is the material used for the beams and girders. To exceed this limit necessitates the use of structural steel beams and girders, and as it is difficult to make a very workmanlike connection for a steel beam to a wooden post, it follows that where long spans are required it is generally the case that the posts and the beams must be of structural steel. But when this is done the cost of the building is at once materially increased.

The amount of window area possible to obtain in a building of mill construction is limited. The brick piers must be made of reasonable width for reasons of stability, if not from considerations of actual supporting strength. The amount of windows that can be used in a given wall is determined by this condition.

The introduction of reinforced-concrete factory construction has furnished a type of factory building free from vibration, and affording longer spans for beams and girders at a reasonable cost, and providing the maximum area of windows in the walls without lessening the strength or rigidity of the structure. All of these defects of the old type of mill construction the modern type of reinforced-concrete factory building has overcome; but it also has introduced some objectionable features peculiar to itself. For example, in the ordinary concrete factory building it is cheaper as to first cost to simply finish the concrete floors with a "granolithic" or "cement" finish. If a wood floor is added on top of the concrete it necessitates laying down wooden screeds, a cinder concrete fill between the screeds, a layer of waterproofing paper, and then the laying of the finished flooring on the screeds. This costs considerably more than the granolithic finish. The objection to granolithic floors for employees of a factory to stand and work on is well grounded, and it cannot easily be downed. The employees complain of rheumatism, of swollen knee joints and a "tired feeling" at night, not usually experienced when working on wood floors. Some factory owners who have had experience in this matter claim that these objections are largely imaginary, and that employees soon become accustomed to the concrete floors and cease their complaints. Other owners in some cases give as their experience that the trouble is real and important, and that no amount of time serves to quiet the dissatisfaction and complaints of their employees. It can be taken as a fact that concrete floors are objectionable, and that wood floors laid over the concrete slabs are expensive.

FIG. 2. VIEW OF INTERIOR OF BUILDING DURING CONSTRUCTION, SHOWING CONCRETE BEAMS WITH TIMBER SPIKING PIECE.

It is often necessary, after a building is prac-

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tically completed, to cut out holes in the floors at various points for chutes, belting, vertical lines of shafting, etc. Now it might appear to any engineer that if such openings in floors were required that the proper way to get them would be to have the requirements all studied in advance and then leave such openings as might be needed in the floors during construction. If this were done it is clear that it would be perfectly easy and practicable to provide the necessary openings in concrete floors without undue expense and without weakening the construction in any way. Mill and factory owners, however, do not take this view of the matter. It is argued by them that often, after the building is all completed and even in use, that a change in the arrangement of machinery, or some unlooked-for requirement, may call for the cutting through of one or more floors. When this possibility is considered, serious objections are made to concrete floors, not alone on account of the actual labor required to cut through solid concrete, but also on account of cutting the reinforcing steel which may be encountered, and thereby weakening the construction. They claim that it is easy to cut an opening in a floor of wooden construction and to frame around it in such a way as to leave the strength practically unimpaired.

Still another objection to the concrete factory building is the difficulty of bolting or fastening machinery to the floors. It is generally impossible to provide inserts in the concrete slab for

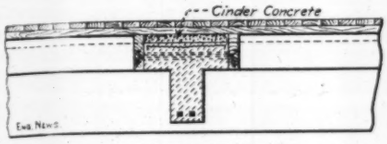


Fig. 3. Detail of Timber Floor Construction on Reinforced-Concrete Beam.

this purpose, as the exact location of the anchor bolts required can seldom be determined in advance. Expansion bolts set into holes drilled into the concrete slabs are expensive, and unless the holes for the expansion bolts are very carefully drilled and the setting very skillfully done, the results are likely to be unsatisfactory. If a wood flooring of maple or birch is laid over the concrete the difficulty of properly fastening down the machinery is actually increased, as the flooring is not sufficiently strong in itself to afford a proper connection for the machinery, and it becomes necessary to anchor the machinery to the concrete slab, and the wood floor only adds to the difficulty.

The attachment of shaft hangers to a concrete construction is easily and satisfactorily accomplished where inserts are provided at the time the concrete is poured, but it is a more difficult proposition in case the location of shafting is to be changed after the concrete work is completed. The same applies to attachments for the sprinkler system and for other purposes. These and other considerations led the writer to design a type of construction adapted to mill and factory buildings that apparently eliminates all of the foregoing objectionable features of either mill construction or reinforced-concrete factory construction of the usual type.

The type of construction referred to can be briefly described as consisting of a skeleton frame of reinforced concrete (that is, the columns, girders and beams), with floors of hard pine plank spanning from beam to beam, and with curtain walls of brick or concrete, as may be desired. The wall panels can be bricked up solid where desired or filled partly with windows with a curtain wall underneath, as shown in Fig. 1, which is a rear view of the new office building recently constructed for the Fore River Shipbuilding Co., at Quincy, Mass. So far as the wall construction is concerned, it will be at once apparent that this presents no novel features, but is exactly similar to the wall construction generally used for concrete factory buildings. The construction of the floors, however, is conceded to be unique not only in the matter of combining a plank flooring with concrete beams and girders, but largely because the beams and girders themselves are of T-sections. Some of the minor details of the construction made necessary in accomplishing this result are also of general interest.

Fig. 2 shows a portion of a floor construction of this type as constructed in the Fore River Shipbuilding Company's office building. It will be noted that the construction shows a series of rectangular openings which are bordered with hard pine (3 × 6 ins. in size). The hard pine framing of these rectangular-shaped borders acts as spiking pieces to which the floor planks are nailed.

Fig. 3 shows a cross-section through a reinforced-concrete beam, and the relative position of the hard pine spiking pieces are there clearly shown. It will be noted that the spiking pieces project above the top of the concrete T of the beam (usually 2 ins.), and that this space is filled with cinder concrete. The object of this is to afford a bearing for the planking entirely across the top of the T of the concrete beams.

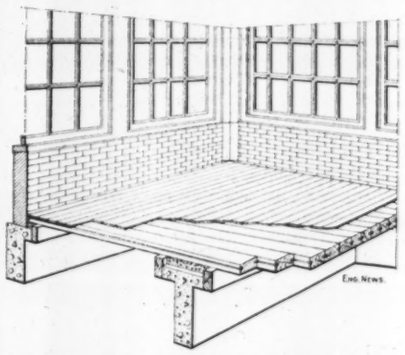


Fig. 4. Perspective View of the Wilson Type of Concrete and Timber Floor Construction.

This cinder fill is finished about ⅛ in. higher than the tops of the spiking pieces, so that while it is necessary to nail the planking to the spiking pieces, yet it is not the intention to have the spiking pieces actually carrying the load of the floor. Another reason why the tops of the spiking pieces are placed so that their tops are practically 2 ins. higher than the tops of the concrete tees is that it is difficult to construct the concrete work so that the concrete tops of the T's would be perfectly level after the concreting is completed. With this arrangement it is not necessary that great exactness in the concrete levels should be required, since the tops of the spiking pieces can afterwards be planed or adzed down to true levels before the plank is laid.

The spiking pieces are secured to the sides of the concrete T's by bolts which pass through gas pipe sleeves, the latter being concreted into the T's. The spiking pieces are used as a part of the concrete forms, acting as a dam for the concrete at the sides of the T's. The gas pipe separators and the bolts connecting the spiking pieces to the concrete T's are all placed before concreting is commenced. This arrangement makes it possible to remove or replace a bolt or any of the spiking pieces at any time, if it should become desirable.

In order to strengthen the concrete T's and to provide for possible concentrated loads acting at their outer edges, the T's are reinforced with steel bars, both transversely and longitudinally, the short transverse bars being bent down at each end.

The fill over the tops of concrete T's designated in Fig. 3 as cinder concrete could, of course, be made of other materials, but cinder concrete has now been used in a number of buildings of this type and seems to fulfill the purpose for which it is intended. The cinder concrete is composed of cement, sand, and finely screened cinders so that it can readily be smoothed off to form a bearing for the floor plank. It is preferred to rest the floor plank on cinder concrete rather than stone concrete as the cinder concrete being more porous is less likely to rot the plank.

Fig. 4 shows a perspective view of the corner of a room in which the plank floor connection to the concrete beams and girders is clearly shown. The girders in the walls support their proportionable part of the floor loads and the curtain walls and windows.

In addition to the building noted above the same system is being applied to the new factory building for C. W. Dean & Co. at Natick, Mass. The factory is five stories high and 50 × 300 ft., with an L for elevators and stairs on both the front and rear of the building. The actual cost of this building including an office building one story high which adjoins it, amounts to only 7.6 cts. per cubic foot. Bids were taken on a building of ordinary concrete construction, and the lowest bid received was $24,000 higher than the contract price using the construction described herein.

The office building for the Fore River Shipbuilding Co. cost 9.2 cts. per cu. ft., including equipment. The same building with factory finish, etc., would, of course, cost much less.

The economy of this construction is due to several causes:

(1) The lighter dead weight of the floor construction requiring for the same strength less reinforcing steel.

(2) Less form lumber, as will be obvious from even a casual study of the construction. Permits standardization of the forms, and renders the erection and removal easy and quick.

(3) All the economy resulting from curtain wall construction as compared to bearing walls is secured by this type of construction.

(4) A saving of time since the frame is quickly erected, and when this is done it is possible to commence work on all parts of the structure simultaneously, as for example, laying brick, laying floors, roofing, setting window frames, plumbing, heating, etc.

Patents have been applied for covering all the novel features of this construction.

A Good Record in Levee Building.

The present project for the control of the Colorado River provides for the construction of a levee 25 miles long near the west bank of the river and south of the international boundary line in old Mexico. The total volume of earth in the levee is 1,300 cu. yds., and a muck ditch from 5 to 12 ft. deep is required in order to cut off the cracked adobe earth and replace the same with selected material to prevent flow of water through the soil below the base of the levee.

The clearing and grubbing required an unusual amount of labor, as deposits had filled in around the trees to a depth of several feet and the elimination of stumps beneath the base of the levee required grubbing to depths reaching 6 to 10 ft.

The borrow pit is on the river side of the levee, leaving a berm of 40 ft. in width from base of levee. The borrow was limited to a depth of 2 ft. next to the berm and increasing in depth to 4 ft. on the further side. Traverses 50 ft. wide were left at intervals of 400 ft. The levees average about 8 ft. in height, crown 8 ft. and side slopes 1 on 3. The adopted grade line is 5 ft. above extreme high water.

The earth has been moved with Fresno scrapers, with four mules to each scraper, the force at one time reaching as high as 1,200 men and 2,196 animals. The whole levee, 1,300,000 cu. yds., and the clearing and grubbing, was completed in 76 days, including Sundays.

There was much annoyance and embarrassment throughout the work incident to carrying equipment and supplies across the border into Mexico, where the Insurrectos raided the construction camps on two occasions.

The work is in charge of Mr. J. A. Ockerson, M. Am. Soc. C. E., and member Mississippi River Commission, who was appointed by the President under the special appropriation for the "protection of lands and property in Imperial Valley, Cal."

Report on the Philadelphia Sewage Purification Experiments.

An interesting and somewhat extensive series of experiments with various methods of sewage treatment was conducted by the City of Philadelphia from March 23, 1909, to May 15, 1910. Broadly speaking, the studies were divided into those relating to preparatory, oxidizing, finishing, disinfecting and diluting processes and the handling and final disposal of sludge. Screens, horizontal (ordinary) settling tanks, a vertical (Imhoff or Emscher) settling tank, primary and secondary contact beds and slate contact beds, primary and secondary sprinkling filters, an intermittent sand filter and a so-called Hamburg filter, in which a layer of fine coke is used to distribute sewage over coarser material, were tested. Experiments were made with calcium hypochlorite as a disinfecting agent. An unusual line of experimentation was designed to show the possibilities of sewage disposal by dilution: crude sewage, after either fine screening or sedimentation, was disinfected with calcium hypochlorite and was then diluted with water in various proportions.

These experiments were entered upon partly as the result of an order issued by the State Department of Health conditioning a permit to make extensions to the Philadelphia Sewerage System upon the submission by the city of a comprehensive plan for both sewage collection and disposal by the year 1912. In accordance with this order, the City Council passed an ordinance on July 20, 1907, directing the Department of Public Works to make the investigations called for and authorizing the employment of necessary engineers and bacteriologists in connection with the work. Before beginning the local detailed studies for collection and disposal works, Mr. Geo. R. Stearns, Director of the Department of Public Works, and Mr. Geo. S. Webster, M. Am. Soc. C. E., Chief Engineer of the Bureau of Surveys, visited various European sewage-disposal works. A report on their observations was submitted to the mayor Feb. 29, 1908 (for abstract see Proc. Engrs. Club, Philadelphia, Jan., 1909). Before and after the European trip, the officials named, accompanied by assistants, visited various American sewage-disposal works. Mr. Rudolph Hering, M. Am. Soc. C. E., New York City, was engaged as consulting engineer in connection with both the comprehensive plan for sewage and with the experiments at the testing station. For a brief period in 1907 Mr. Harry B. Hommon gave advice as chemist in connection with the testing station and the systematizing of the work of the chemical laboratory.

The experiments were under the general direction of Mr. Webster, but were conducted under the Sewage Disposal Division of the Bureau of Surveys in direct charge of Mr. Geo. E. Datesman, M. Am. Soc. C. E., Principal Assistant Engineer. Mr. W. L. Stevenson, Assoc. M. Am Soc C E, was Assistant Engineer in charge; Mr. Geo. G. Eysenbach was chemist. In addition there was an assistant chemist and two assistant bacteriologists.

As a basis for the experiment station, use was made of the Spring Garden water-purification testing station built in 1901 in Fairmount Park. The sewage used for the experiments was taken from an area of some 4,500 acres, of which there is "at least 1,500 acres built up and contributing drainage which is of very diverse characteristics." The sewers in this section are on the separate system, and as we understand it no storm water except that due to leakage had access to the sewer drawn upon to supply the testing station. The sewage contained large quantities of trade wastes. The sewer drawn from is 4 ft. 7 ins. in diameter and usually has 32 ins. depth of flow. Connection was made with the intercepting sewer by means of an 8-in. vitrified pipe laid at right angles to the larger sewer and terminating 15 ins. above the invert. This connecting pipe discharged into a pump well 3½ ft. in diameter by 13 ft. deep, from which a 6-in. suction pipe extending within 1 ft. of the bottom of the well was connected with a pump and discharged sewage to the testing station through a 4-in. cast-iron force main about 413 ft. long. The total lift was about 90 ft.

SCREEN.—The fine mesh screen exposed a conical surface and was composed of red metal cloth with clear openings 0.5 mm. square. The sewage was applied to this screen through 24 nozzles, each of ¼-in. diameter, set to discharge at right angles to the conical surface of the screen.

HORIZONTAL-FLOW SETTLING TANKS.—The horizontal or ordinary settling tanks were three in number. One, named No. 12, had a ratio of depth to length of 1½ to 1 and a capacity of 9,943 gals. No. 13 had a ratio of depth to length of 1 to 2½ and a capacity of 7,767 gals. Each of these tanks at first had level bottoms and baffles or scum boards. In August, 1909, each of these tanks was equipped with bottoms sloping 16° to the horizontal toward the inlet end, with a transverse brick baffle scum board at midlength and inclined scum boards placed about the effluent collecting pipe. By these changes, the capacity of tank No. 12 was reduced to 8,738 gals., and of No. 13 to 5,475 gals. The third horizontal-flow sedimentation tank (No. 17) "was of better proportion, the ratio of depth to length being 1 to 4." Its bottom was almost level. Up to the latter part of September, 1909, there were no baffles in this tank, but at that time two baffle walls with scum boards were built across the tank and the outlet was protected by an inclined scum board.

VERTICAL-FLOW SETTLING TANKS.—The vertical flow (Emscher or Imhoff tank) was originally 5 ft. in diameter and 6 ft. deep, but in January, 1910, its depth was increased to 10 ft. Within this tank was placed a concrete bottom in the shape of an inverted cone with sides 30° to the horizontal. At 4 ft. above the bottom, a galvanized-iron baffle was attached to the sides of the wooden tank, and upon this was placed an inverted funnel and a ventilating stem, concentric with which was a circular baffle extending above the surface of the water. Sewage was admitted from a circular weir concentric with the funnel.

SLATE BED.—A Dibdin slate bed 0.0021-acre in area and 5 ft. deep was installed and equipped with 19 horizontal layers of 12 × 24-in. slates, separated by brickbats so as to leave a clear space of about 3 ins. between them.

CONTACT BEDS.—The primary contact bed had an area of 0.0066-acre and a depth of 3 ft., consisting of brick underdrains and ½ to 2-in. slag. The secondary contact bed was 0.00585-acre. It also had a depth of 3 ft. with brick underdrains, above which was hard furnace clinker rejected by a ½-in. screen.

PERCOLATING FILTERS.—There were 14 percolating filters altogether; a battery of six outside the building, while within the building there were two large filters, a battery of five small ones and a Hamburg filter. The sewage applied to the outside percolating filters had been roughly settled in a wooden tank 10 ft. in diameter and 9 ft. 3 ins. deep, containing 5,600 gals. The six outside percolating filters had areas of 0.002-acre, so arranged as to form three squares, each provided with a Columbus nozzle operating under a falling head from the dosing tank. Two of these beds were filled with limestone, one with slag, two with trap and one with gravel, the depths varying from 4 to 9 ft. and the material ranging in size from ½ to 3 ins. for one of the trap filters and from 2¼ to 4 ins. for one of the limestone filters. Two of the beds had underdrains 9 ins. deep, and the underdrains of the other four were 1 ft. deep.

Of the two large percolating filters, the upper one had an area of 0.01175-acre, filled above the underdrains to a depth of 6 ft. with hard clinker rejected by ½-in. screen. The sewage applied to this bed had been roughly screened through ½ and ¼-in. screens "to remove only those particles likely to clog nozzles." Constant head was maintained in the dosing tank by means of a float valve and the butterfly valve was used to produce an undulating head on the nozzles. Taylor square nozzles, followed by Reading [illegible] were used on this bed.

The lower percolating filter appears [illegible] have been of the same size as the upper one, [illegible] was filled differently. It had underdrains [illegible] 6-in. split vitrified pipe laid on a slightly [illegible] ping floor. These connected with a 6-in. semi-[illegible] cular main drain along the center line of th[illegible] and covered with 12x24-in. slates laid longitu[illegible] ally above which were "three 4-in. vitrified [illegible] pipes perforated by ¼-in. holes." These pip[illegible] were placed vertically to form ventilators. A[illegible] g the sides and in the corners "ventilators of [illegible] same type as underdrain tile" were placed [illegible] end. The vertical ventilating pipes were [illegible] nected with horizontal 3-in. perforated pipes [illegible] 3 ft. below the surface. These horizontal pi[illegible] were perforated, but the upper holes were p[illegible] ged to prevent water entering the pipes. Th[illegible] hori-zontal ventilating pipes were connecte[illegible] to the vertical pipes placed above the main dr[illegible]. All the vertical ventilating pipes "extend[illegible] to the surface of the media, where circular t[illegible] cotta caps were cemented on, giving a con[illegible]te in-ternal ventilating system." This ventila[illegible]g system was connected at one corner of the [illegible]d with a 6-in. galvanized-iron chimney provid[illegible] at the top with a ventilating cowl. The effl[illegible]t pipe was trapped to prevent air entering [illegible] main drain.

The material composing this lower p[illegible]olating filter was ¾ to 1½-in. hard stone, 6½ [illegible] deep. The bed was dosed with the effluent o[illegible] settling tank No. 12 (mentioned above); that i[illegible] it re-ceived sewage which had been both screened and settled. Two square-spray Taylor nozzles were used to serve this bed. When an undulating head was desired, this was secured as has just been described for the upper bed

except that the water wheel was geared down by means of a worm instead of a link belt and pinion. The cam was so designed that the nozzle was playing almost the entire time, rendering the distribution nearly perfect. The effluent was measured by a hook gage and "V"-notch weir and then passed to the drain.

The five small percolating filters were used to "study the effect of bacterial surface." They were placed in an existing wooden tank having five compartments. The tank was provided with a false floor of ¼-in. mesh wire. On this wire was placed 18 ins. of different kinds of media, all of which had passed through a ⅝-in. screen and had been rejected by a ½-in. mesh. One of these small beds was filled with common marbles (spheres); one with gravel (spheroids) and the remaining three with the regular-shaped material, two being broken slag and one broken coke. These beds were dosed by means of Stoddard trays of galvanized iron. To them the applied sewage was screened and settled (from tank No. 12, described above).

HAMBURG PERCOLATING FILTER.—The Hamburg filter (named after Dr. Dunbar of the Hygienic Institute of Hamburg) had a surface area of 8 sq. ft., and was provided with a sloping concrete bottom. On this was laid 2 ft. 4 ins. of clinkers ranging in size from "fist to child's head." The spaces between the top of this layer of large material were filled with 1⅛-in. (30 mm.) clinker. This served as the bed for the distributing media, which, together with the further arrangement of the Hamburg filter, is described in the report as follows:

First a 4-in. layer of ⅜ to 1¼-in. (10 to 30 mm.) clinker, then 4 ins. of ⅛ to ⅜-in. (3 to 10 mm.) coke and 14 ins. of 1/25 to ⅛-in. (1 to 3 mm.) coke.

These distributing layers were banked up against the sides so that the upper surface formed a basin. Ventilation of the media was obtained by boring 1-in. holes around the tank below the distributing layers and by the opening for the effluent.

The dose was applied by hand from a cylindrical reservoir which could be filled with the effluent of settling tank No. 17 by opening a valve.

Settling tanks were provided for the sprinkling filter effluents.

INTERMITTENT SAND FILTER.—The intermittent sand filter had an area of 0.002-acre. It consisted of 18 ins. of round-grained sand with an effective size of 0.6-mm. and a uniformity coefficient of 1.45. The sand rested on under drains of 6-in. split tiles surrounded by broken stone and gravel to prevent the sand reaching the drain. This bed was dosed with effluent from the slate bed.

DISINFECTION.—The studies of disinfection

were designed more particularly to show the "practicability of disinfecting sewage from which the largest suspended solids had been removed," since the disinfection of sprinkling filters had already been studied elsewhere. Three 5-ft. circular wooden tanks were used with an overflow set to give a depth of 4 ft. and baffled to produce a comparatively high velocity. The calcium hypochlorite was applied to screened sewage and to settled sewage from tanks Nos. 12 and 13, already described.

For the dilution studies, designed "to determine the oxidizing power of river water," there was used a tank having a capacity of 35,600 gals., provided with proper dosing and measuring devices. The tank was provided with six galvanized iron baffles.

An excellent summary of the conclusions derived from the Philadelphia experiments is given in the report and is copied here in full:

Fine Mesh Screening.

The 60-mesh per inch screen removed one-third of the suspended matter in the crude sewage as applied; prevented the formation of scum in subsequent sedimentation tanks and prevented the clogging of nozzle orifices on the sprinkling filters.

Sedimentation.

For the purpose of comparison, the results of sedimentation are given in percentage removal, although it is recognized that effluents which are produced with equal percentage removal are not comparable on the basis of solids content.

HORIZONTAL FLOW.—Three and one-half hours nominal flow through a baffled sedimentation tank removed two-thirds of the suspended solids in the crude sewage; an increased storage did not produce a proportionate improvement in the efficiency of the tank. Baffling by equalizing velocity through the cross section prevented dead spots in the tank and restrained sludge and scum at the inlet end.

Between periods of three and a half to six hours flow the influent was not deoxidized nor rendered offensive when sprayed upon sprinkling filters. To prevent septic action the tanks required sludging and washing out every six weeks.

VERTICAL FLOW.—The Emscher or Imhoff tank studied illustrated the principle involved, inasmuch as the substantial separation of the sewage flow from the digesting sludge keeps the sewage fresh and eliminates offensive odors either in the effluent, the sludge or in the gas developed.

The removal of suspended solids from the crude sewage was but little more than one-half due to the shallowness of the tank; the efficiency may be increased in tanks of working size.

Slate Contact Beds.

The best results were accomplished when this bed was filled twice a day, or at a rate of 2,000,000 gals. per acre per day.

Crude sewage applied, deposited three-fourths of the suspended solids; the effluent was slightly nitrified and rendered partially stable.

The deposit on the slates was inodorous, resembling earth, and could be removed by flushing in the small size bed experimented with.

Where slates are not a waste product the construction of the bed would be costly.

Contact System.

The primary and secondary beds treating settled sewage did not mature sufficiently to yield a stable effluent, although it was very low in suspended matter. The highest rate obtained was 1,350,000 gals. per acre per day. With sewage containing less trade waste better results might have been obtained.

Sprinkling Filters

DISTRIBUTION.—Best results were obtained with fixed sprinkler nozzles when the film of sewage was made to constantly travel back and forth over the media, without a resting period; this caused a uniform rate of flow from the underdrains.

RATE OF OPERATION.—A regular uniform rate of operation produced better results than the same net rate obtained irregularly. With filters exposed to the weather and receiving sewage partially settled, the maximum rate obtained was 2,500,000 gals. per acre per day, but in the winter the stability of the effluent deteriorated.

With a filter protected from the weather, having fine screened and settled sewage uniformly distributed over its surface, and having a ventilating system, the maximum used rate was 3,100,000 gals. per acre per day. The effluent was practically always stable. How far this would have been effected by exposure to the weather was not determined.

KIND OF MEDIA.—Trap and gravel maintained their initial size. Limestone and slag disintegrated to a slight extent.

The smooth surface of the gravel stones was not as well adapted to the formation of a bacterial jelly as rougher media, and the extreme roughness of slag caused it to retain the deposited solids.

The rough, irregular cinders removed all the suspended matter from coarsely screened sewage, so that clogging soon ruined the bed.

SIZE OF MEDIA.—The completeness of preliminary treatment partially controls the size of media in subsequent filtration.

In filters exposed to the weather and receiving sewage partially settled, operating at 2,500,000 gals. per acre per day, best results were obtained from trap media 1 to 3 ins. in size. Under the more favorable conditions of fine screened and settled sewage as an influent uniformly distributed, at a rate of 3,100,000 gals. per acre per day, media ¾ to 1½ ins. produced an excellent effluent.

DEPTH OF BED.—Filters of less depth than 6 ft. were not satisfactory, but from filters 6 ft. or more in depth, effluents could be obtained at rates between 2,500,000 and 3,000,000 gals. per acre per day of satisfactory quality. The additional depth over 6½ ft. did not seem to be economical.

MATURING.—Filters exposed to the weather, receiving sewage partially settled, and put in operation in March, yielded a satisfactory effluent in three weeks, and after three months the effluent was perfectly stable.

A filter protected from the weather, having fine screened and settled sewage uniformly distributed over its surface, and put in operation in July, yielded a perfectly stable effluent after one week of service.

UNLOADING.—In filters operated at rates between 2,500,000 and 3,000,000 gals. per acre per day, media composed of stones approximately uniform in size completely unloaded the solids stored up in the interstices, whereas media composed of stones of great diversity in size became badly clogged but did not unload.

EFFECT OF FREEZING TEMPERATURE.—No trouble was experienced from the formation of ice upon the surface of the filters; biological activity was decreased by the low temperature to such an extent, however, that at a rate of 2,500,000 gals. per acre per day the fine grain and graded mixture beds pooled and the effluents of all the exposed filters were of lower stability than in summer.

ELIMINATION OF SURFACE GROWTH.—Fungus growths on the surface were completely removed by an application of calcium hypochlorite dissolved in water.

The continual disinfection with calcium hypochlorite of the influent to a filter maintained its surface in perfect condition and did not interfere with the biological action of the bed.

BACTERIAL EFFICIENCY.—The average number of bacteria in the effluent of a mature sprinkling filter operated at rates between 2,500,000 and 3,000,000 gals. per acre per day was 400,000 per cc., which represented a removal of 86% from the crude sewage.

Bacterial efficiency within a limited range of small size stone was proportional to depth of bed.

SETTLEMENT OF THE EFFLUENT.—When the effluent was passed through a settling basin in two hours much improvement was obtained by the removal of the suspended matter.

Hamburg and Intermittent Sand Filter.

A filter modeled after the so-called Hamburg type, in which distribution is effected by a layer of fine coke; also a shallow, coarse-size sand filter, both operated at too low a rate to be economical, for the conditions in Philadelphia.

Disinfection.

Fresh sewage from which suspended matter larger than 1-25 in. had been removed was disinfected to a practical degree with calcium hypochlorite; the amount of disinfectant required depended upon the amount and condition of the organic matter in the sewage.

Economy of design and operation can be attained by short storage and mechanical agitation to insure a contact of the disinfectant and the sewage.

Dilution.

Crude sewage when passed through a fine mesh screen or satisfactorily settled to remove the solids larger than 1-25 in. and disinfected with calcium hypochlorite to yield six parts per million available chlorine was added to river water in proportions up to 1 to 10, and its purification accomplished without offense to sight or smell nor the depletion of the dissolved oxygen of the river water below 50% saturation.

Sludge.

AMOUNT.—Horizontal flow in sedimentation tanks produced sludge 88% moisture at an average rate of 5 cu. yds. per 1,000,000 gals. sewage.

An Emscher tank with 4½ ft. vertical flow produced sludge 82.6% moisture at an average rate of 0.9-cu. yd. per 1,000,000 gals. sewage.

CONDITION.—Cleaning plain sedimentation tanks caused considerable offense, but the sludge withdrawn from the Emscher tank had a tarry odor and was not offensive.

Scum formed on sedimentation tanks except when the influent was screened.

DIGESTION.—The placing of sludge from a sedimentation tank in a water-tight, uncovered tank for digestion did not prove successful.

LAGOONING.—Wet sludge from plain sedimentation tanks placed in earth lagoons to a depth of 12 ins. in moderate weather, dried to a consistency fit to remove within the six weeks elapsing between cleaning tanks, and its volume was 0.4 of that applied.

SLUDGE BED.—Fine sand or sawdust over a coarse stone drainage floor was more efficient for reducing moisture in sludge than a plain earth lagoon.

Wet sludge from a sedimentation tank, applied 6 ins. deep in winter weather, under cover, dried to a consistency fit to remove in six days and under the same conditions but not under cover, in twelve days.

Based upon small size tests in winter weather, Emscher sludge 12 ins. deep upon a sand bed, dried to a consistency fit to remove in twelve days during freezing weather. In Germany the time is given as from four to five days, but sludge is not withdrawn in freezing weather which accounts for the difference.

When equal weights of rice coal and wet sludge were mixed and placed on sludge beds, the mixture was fit to remove in one day, and was successfully burnt.

Bascule Street-Crossing of an Overhead Carrier Track.

The view below shows an overhead carrier or "trolley" track crossing a street by an arrangement which keeps the street clear of overhead obstruction. The track beam is made into a two-leaf bascule bridge, with hinges at end supports, counterweighted tail sections, and a supporting bracket on a pier in the middle of the street to receive the outer ends of the leaves. This is part of a foundry carrier system at Gelsenkirchen, Germany, described by E. A. Schott in "Stahl und Eisen" of Jan 26, 1911.

BASCULE LIFT STREET-CROSSING OF AN OVERHEAD CARRIER-TRACK SYSTEM IN A FOUNDRY PLANT.

OILING LOCOMOTIVE TIRES.—A train passing a curve slowly makes a squeaking noise caused by the wheels grinding against the rails and if the train passes at high speed the grinding action is still there although one cannot hear the noise. This is destructive practice as the wheels and rails grind each other and the locomotive has to furnish the power for it. To avoid these losses some roads are overcoming this friction at the locomotives by greasing the flanges of the driving wheels, with very good results.

The Wabash-Pittsburg Terminal R. R. has given this matter careful consideration. On the West Side belt tracks in Pittsburg, with their sharp curves, the driving wheel tires suffered greatly until it was found that the life of the tires could be tripled or quadrupled, by oiling the flanges. Flange oilers have been tried for years but without much success until recently, when it was discovered that a heavy asphaltum oil conveyed from the cab to the wheel flanges by a jet of steam becomes sticky so that it can be applied to the flanges without spreading to the tread of the wheel. This road has since equipped many of their engines with this device and the saving effected is enormous, if you consider the cost of re-turning the tires, the expense of remounting the wheels, the loss in metal turned off the tread, the loss in revenue during the time the engine is standing in the shop, and lastly, that the rails are saved as much as the tires.—From a paper by O. Stuckl, "Achievements in Railroading," before the Engineers' Society of Western Pennsylvania, Mechanical Section, "Proceedings" for March, 1911.

The Oxhydric Process for Cutting and Welding Metal.

Side by side with the oxy-acetylene process of cutting and welding metals there has been developed a very similar system in which the acetylene is replaced by hydrogen.* The hydrogen system has been developed extensively, on a commercial basis, for cutting purposes. A double-jet torch is used which delivers a jet of oxygen and hydrogen, mixed, to heat the metal and a jet of oxygen to cut it. Heat enough is supplied by the first jet so that the oxide formed by the second jet is sufficiently fluid to flow away rapidly (or in heavy work it is kept hot and blown away by a third jet). The cut made in this way is very clean and regular, like that of a saw.

FIG. 1. CUTTING A STEEL BILLET WITH A TRIPLE-NOZZLE OXY-HYDROGEN TORCH.
(The tank in front of the gas bottles is the mixer.)

The oxhydric torch is the invention of a Belgian, Mr. Jottrand. The patents are owned by the Societe Oxhydrique Internationale, of Brussels, Belgium. The rights to the use of the system in the United States and Canada are held by the American Oxhydric Co., of Milwaukee, Wis.

The company plans to establish several plants for the manufacture of the gases, these being located at convenient points, and the compressed gases being shipped in steel tanks or "bottles" to the various industries using the process. At the Milwaukee plant the generating, compressing and welding rooms are on the first floor of a fireproof building having brick walls, concrete floors, and concrete covering for all the steel roof construction.

The oxygen and hydrogen gases (in proportions of 1 to 2) are generated by the electrolytic decomposition of water, a proportion of caustic soda being added to the water (sodium-hydroxide solution) for the purpose of increasing its conductivity. Direct current of 400 amperes is passed through battery cells consisting of steel plates immersed in the water, and the electromotive force is about 2.6 volts per cell. The hydrogen collects at the cathode and the oxygen at the anode of each cell. The hydrogen comes away practically pure, any impurities being generally in the oxygen; the latter is about 96% pure, and is passed through a purifier by which its purity is increased to about 99% (or even better). Tests of the gases are taken by analysis three times each hour. The normal pressure in the gas receivers is about 0.4 lb. per sq. in. The equipment of the generating room consists of about 120 rectangular tanks 30 × 46 ins. in plan, each having about 150 gallons of water covering the electrodes. The temperature of the room is maintained uniformly at about 74° F. The daily capacity of this generating plant is about 8,000 cu. ft. of oxygen and 16,000 cu. ft. of hydrogen, while the two gas receivers have a storage capacity of 15,000 and 30,000 cu. ft. respectively. The tanks are of steel with welded joints, and the groups of electrolizers are welded also. The piping is of steel with welded joints; the pipes leading to and from the receivers are laid underground and embedded in concrete. A duplicate generating set is now being installed.

The two Schultz gas compressors are of German manufacture, and are three-stage machines with vertical inverted cylinders; the low-pressure cylinder is 4 ins. in diameter with a stroke of 8 ins.; the intermediate cylinder 2¼ × 6 ins., and the high pressure cylinder 1¼ × 4 ins. On account of the heat generated by compression of the gas, the cylinders are set in a tank of water, and have cooling coils between them. The gas from the high-pressure cylinders is passed through two cooling coils, and then to a water separator on the outside of the tank. Beyond this separator is the pipe connection for charging the portable tanks or "bottles." The plungers are packed with cup leathers made from a special leather, which is entirely free from oily matter. No oil is permissible in the cylinders, and the cylinder lubrication for the oxygen compressor is by distilled water, with glycerine and water for the packing, and oil only for the crankshaft. In the hydrogen compressor, the glycerine and water mixture is used for both the cylinder and packing, with oil on the crankshaft bearings. The pressures for the three stages are 88, 882 and 2,200 lbs. per sq. in. The compressors are belted to a shaft driven by a 12-HP. motor, and they run normally at about 123 r. p. m. Their safety valves are set to blow off at 160 atmospheres (2,336 lbs. per sq. in.), and they have each a compressing capacity of 10,000 cu. ft. per day.

The seamless steel bottles are of German manufacture, and each contains about 240 cu. ft. of gas at a pressure of 150 atmospheres, or 2,200 lbs. per sq. in. The bottles are said to be both lighter and stronger than those of American make, and are tested to a pressure of about 4,750 lbs. per sq. in. They are 6¼ ft. long, 8 in. inside diameter and ¼-in. thick. Each bottle has a rectangular base of pressed steel welded upon it, making it more stable. The top of each bottle is fitted with a needle valve, and with a pressure regulator governing the flow, so that the gas will be delivered to the mixer and thence to the torch or burner at a constant pressure. Two pressure gages show the storage and working pressures.

In using the process, two bottles are placed side by side, and for the oxy-hydrogen jet (for heating the metal) the two gases are led by armored rubber tubing from the regulators to a mixer consisting of a coil of pipe (with connection for both bottles) immersed in water. The mixer is water sealed and is so arranged that in the event of a flashback (due to improper handling of the burner) the flame cannot get beyond the mixer. Flexible armored tubes from the mixer are connected to metal pipes clamped together and forming the torch. Each pipe is fitted with a valve and ends in a nozzle or burner.

In ordinary work, the torch is held by the operator and the vertical end is fitted with a carrier having two small wheels which rest on the piece to be cut, so that the burners are held at a fixed distance from the metal, as in Fig. 1. For careful work, however, such as cutting locomotive frame plates, connecting rods, and plate work generally, the burner is attached to a sliding frame like the carriage of a lathe. This carriage travels along a frame, being moved by a lead screw, and has also a lateral travel at right angles to this screw. The carriage may be arranged to swivel on the slide, so that it can be turned horizontally to any angle, while the burner can be swiveled vertically so as to undercut the metal and thus confine the flame. This last is especially necessary on finishing a cut, as the flame is likely to blow out at the bottom corner and so leave a ragged finish to the cut (or leave the corner uncut). This machine can be clamped upon the work to be cut. Special machines are made for cutting pipe (up to 24 ins. diameter) and for cutting openings in pipe for branch connections.

The torch (Fig. 2) has either two or three nozzles, according to whether the thickness of the steel is under or over 5 ins. The first of these supplies a mixture of oxygen and hydrogen for pre-heating the metal; the second delivers the oxygen jet which actually does the cutting. The gas for this jet is piped direct from the bottle. The third nozzle, for heavy work, is an after-heater for an oxhydric flame which keeps hot the iron oxide (caused by the cut) and blows it away from the cut. Particles of free carbon in

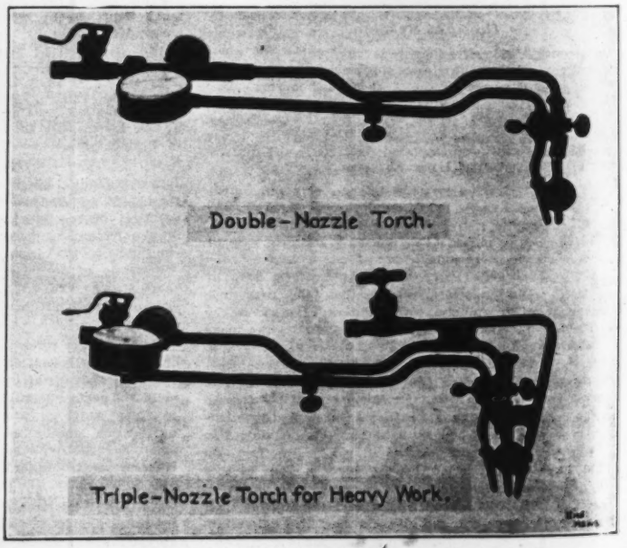


FIG. 2. OXY-HYDROGEN TORCHES FOR CUTTING METAL.

*Articles on oxy-acetylene welding were published in Eng. News, 1907, I.—706 and 1908, II.—547.

the steel make little explosions and a shower of sparks like those from a tool grinder.

It was at first believed that a fine stream of gas at high velocity was necessary for clean accurate cutting, but this has been found to be incorrect and the torch as made by the American Oxhydric Co. has comparatively large nozzle openings of circular cross section, which deliver a volume of gas at low velocity. Since oxhydric cutting is simply oxidizing the metal at the proper temperature, the speed of cutting depends on the rapidity with which the metal is heated to the proper temperature. If the torch is moved too slowly, some of the gases will be wasted, while if it is moved too rapidly the oxidation will be incomplete and the cut will not reach all the way through. The cut can be made at the rate of about 6 ins. per min. in metal 2½ to 3½ ins. thick, or 4 ins. per min. in from 4 to 9-in. armor plate. A pressure of 34 lbs. per sq. in. for the oxygen (cutting) jet is sufficient for metal up to 6 ins. in thickness, and 105 lbs. for metal up to 24 ins. thick.

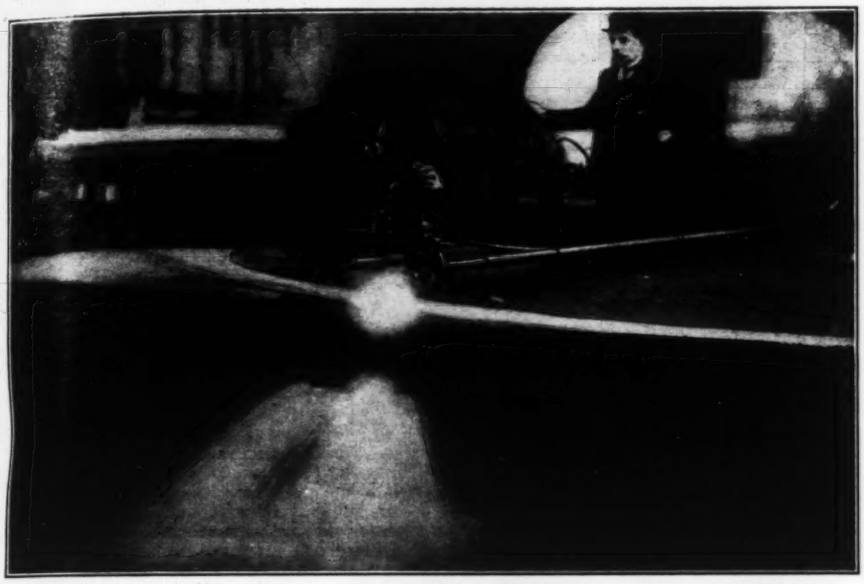


FIG. 3. CUTTING ARMOR-PLATE TO EXACT SHAPE WITH THE OXY-HYDROGEN TORCH MOUNTED ON A CARRIAGE.

GAS CONSUMPTION IN CUTTING METAL WITH OXHYDRIC BLOW PIPE.

Thickness of metal ins.	Gas consumption Cu. ft. per lineal ft. of cut. Oxygen.	Hydrogen.	Time for 12-in. cut, min.	sec.
¼	1.5	1.5	1	0
1	3.5	3.3	1	30
2	6.	4.	1	30
4	16.	7.6	3	0
6	27.5	11.2	3	0

The process does not reduce the ductility of the metal, as the operation is so rapid that the heat is not transmitted to the mass of the metal. Thus with the exception of about 1-64 to 1-100-in. the metal retains its original chemical composition and physical properties. The process can be used equally well on high-carbon and low-carbon steel and on special steels treated by hardening or tempering processes, or with nickel, chrome or manganese added to produce hard grades of steel.

The process can be applied to any grade of wrought iron or steel, but not to cast iron (owing to the presence of many unoxidizable particles), or to copper or brass. It can be used for exact and accurate work like the cutting of die-blocks (from hard manganese steel which can hardly be touched by a tool), or for rough and heavy work such as cutting armor plate, cutting up scrap or cutting off the sinking heads of large steel castings. It is specially advantageous for work that cannot be brought to a saw or shear, and it is much more rapid than sawing. Thus a billet or blank that would take four or five hours to saw can be cut by the oxhydric process in from 5 to 10 minutes; and test pieces are cut from armor plate in 10 minutes which were formerly drilled out in about 18 hours. With careful handling, a very smooth cut can be made, the surface showing slight marks or striations like those of a saw cut. The width of the cut or kerf is practically uniform, even in deep cuts, and is usually about ⅛-in. in thin material or ⅜-in. in heavy material.

The process is used for cutting and trimming armor plate by the large steel companies, and Fig. 3 shows it making a circular cut on a 9-in. armor plate of nickel-chrome steel. For this purpose, the torch was mounted on one end of a radius rod having its other end fitted to a pivot. This cut was made at the rate of 1 ft. in 2¼ mins. Tangled wreckage of structural steel at the boiler house of the Pabst Brewery (after a boiler explosion) and at the Milwaukee plant of the American Bridge Co. (after a fire) was cut up for removal by this process. It was used also in wrecking an old power plant of the Milwaukee Electric Ry. & Light Co., the dynamo castings, etc., being cut up into convenient size for handling. On some suburban bridges 66 gusset plates were cut away to allow the passage of new electric railway equipment of increased width.

The process is used also for welding steel, iron, copper, brass, aluminum and other metals. For such work the oxy-hydrogen flame is of less intensity than that for cutting metal, the proportions being about one part oxygen and four to six parts hydrogen. The two gases are carried from the steel storage bottles to the mixer, and thence through a single flexible tube to the torch. An enlargement at the entering end of the torch reduces the velocity of the gases considerably, and beyond this a tapering tube of decreasing diameter extends to the nozzle, causing the velocity to be increased to the desired extent. This velocity of the gases is a very important feature. In order to obtain a perfectly homogeneous flame it is necessary to ensure complete absorption of the oxygen by the hydrogen in excess, and this presented a difficulty due to the danger of mixing the two gases before their ignition. The problem was solved by giving to the mixture a velocity greater than that of the propagation of flame, so that the flame cannot flash back into the torch or tube. At the same time, the velocity must not be so great as to blow away or divert the molten metal at the weld.

The oxhydric welding can be applied to any metals that can be fused, and for either thick or thin metal. It is not claimed, however, to be especially adapted for welding large work, except where it is necessary not to change the character of the metal. In such cases, the process is of advantage, since the flame is absolutely neutral. As a development of the welding process, it can be used to fill holes in plates (such as those drilled incorrectly for riveting), or blow-holes and cracks in castings. New teeth can be welded upon gear wheels, new metal welded or built up upon worn parts, shafts repaired, etc. The welding process is applicable to enameled ware, leaving the surface in proper condition to receive the enamel.

Rail Mill Practice.

The report presented by the Rail Committee at the recent annual meeting of the American railway Engineering Association included a table compiled by Robert W. Hunt & Co. to show the equipment and practice in rail manufacture at a number of mills. This table is given below, and the figures represent nominal practice.

The following explanatory notes are given. The Lorain Co. rolls chiefly girder and tee-girder rails. The Pennsylvania Co.'s figures are for standard sections only. The Tennessee Co. and the Dominion Co. use duplex-process steel, while the Maryland Co.'s work may be duplex-process steel. The Carnegie Co. may roll open-hearth steel from the Homestead plant. In two-high blooming mills the rails may be given more passes than the number stated on the table.

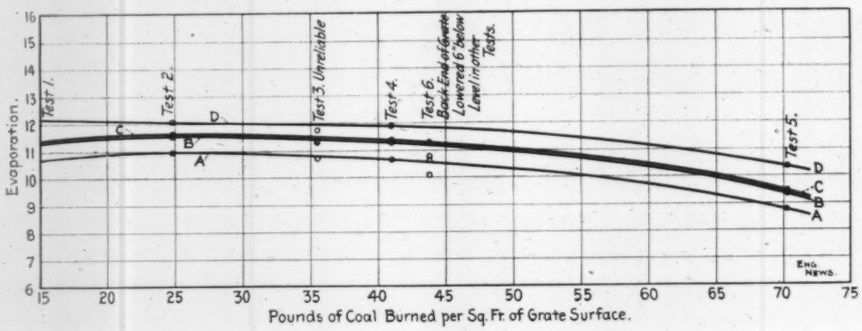
TABLE OF RAIL MILL PRACTICE.

	Company and Mill.	Steel.	No. of converters or furnaces.	Size of ingot at bottom. ins.	No. of ingots per heat.	Nom. No. of 90-lb. rails per ingot.	Bloom mill; roll high.	Nom. No. of passes bloom mill.	Blooms re-heated.	No. of passes Rail mill train.	No. of passes Total ingot to rail.	No. of saws Hot saws.	No. of saws Extra hot saws.	Dist. from fin. rolls to first hot saw, ft.	Time from first saw to leaving fin. rolls* secs.	Brand on top or bottom.	Brand on rail reads from which end of ingot.
1.	Algoma Steel Co., Sault Ste. Marie, Canada.	Bess.	2		2												Top generally
		O. H.	3	18 × 19½	15	4-5	2	17	Yes	11	28	1	1	113	25-30	Bottom	
2.	Bethlehem Steel Co., Bethlehem, Pa.	O. H.	10	19 × 23	25	6	2	15	No	11	26	1	1	270	35-40	Bottom	Bottom
3.	Cambria Steel Co., Johnstown, Pa.	Bess.	4		4	5											
		O. H.	..	19¾ × 22¾	...	...	2	15	Yes	12	27	4	0	77	15-20	Bottom	Bottom
4.	Carnegie Steel Co., Braddock, Pa.	Bess.	4	18½ × 19½	7-8	4-5	3	7	Yes	13	20	4	0	43	12-16	Bottom	Bottom
5.	Colorado Fuel & Iron Co., Pueblo, Colo.	O. H.	12	18 × 20	30	4	2	15	No	10	25	1	0	105	25-30	Top	Top
6.	Dominion Iron & Steel Co., Sydney, N. S.	O. H.	10	18½ × 21½	18	6	2	17	No	11	28	1	0	107	10-15	Bottom	Top
7.	Illinois Steel Co., Gary, Ind.	O. H.	28	20 × 24	24	7	3-2	9	No	9	18	5	0	158	12-18	Bottom	Bottom
8.	Illinois Steel Co., South Chicago, Ill.	Bess.	3	18½ × 19	6-7	4	3	9	No	9	18	5	0	95	10-15	Bottom	Bottom
9.	Lackawanna Steel Co., Buffalo, N. Y.	Bess.	4		6												
		O. H.	12	9 × 19	34	4	2	6	No	9	15	1	1	232	12-18	Bottom	Top
10.	Lorain Steel Co., Lorain, Ohio.	Bess.	3		6												
		O. H.	6	22 × 26	20	...	2	..	Yes	..	..	..	..	..	....	Bottom	.....
11.	Maryland Steel Co., Sparrows Point, Md.	O. H.	5	19 × 21	16	5-6	2	13	No	11	24	1	1	..	28-32	Bottom	Bottom
12.	Monterey Iron & Steel Co., Monterey, Mexico.	Bess.	3														
		O. H.	4	17 × 22	16	4	2	15	Yes	10	25	1	0	205	40-50	Top	Bottom
13.	Pennsylvania Steel Co., Steelton, Pa.	Bess.	3														
		O. H.	5	18½ × 18½	30	4	3	9	Yes	11	20	2	1	8	10-14	Top	....
14.	Tennessee Coal, I. & Ry. Co., Ensley, Ala.	O.H.	8	19 × 23	30	6	2	11	No	10	21	4	0	113	15-20	Bottom	Top

*The time given is that consumed from the rolls until the first rail is cut.

Acceptance Test of a Babcock & Wilcox Marine Boiler for the U. S. Navy: Good Performance at High Rate of Combustion.

The results of an interesting test of a water-tube marine boiler are reported in a paper by Lieut.-Commander H. C. Dinger, U. S. N., published in the November, 1910, "Journal" of the American Society of Naval Engineers. The boiler, built by the Babcock & Wilcox Co., was a sample one representing the type to be installed on the U. S. battleships "Wyoming" and "Arkansas." It was similar in all respects to those which will be installed on the vessels except that it was only half as wide. The actual boilers have a grate surface of 119 sq. ft. and a heating surface of 5,353 sq. ft., instead of the 58 sq. ft. of grate and 2,571 sq. ft. of heating surface in the test boiler.



CURVES SHOWING EFFECT OF RISING RATES OF COMBUSTION ON THE EVAPORATION PER POUND OF COAL IN A MARINE WATER-TUBE BOILER.

Curve A Water apparently evaporated under actual conditions per pound of coal as fired.
B Apparent equivalent evaporation from and at 212° per pound of coal (including moisture).
C Equivalent evaporation from and at 212° per pound of dry coal.
D Equivalent evaporation from and at 212° per pound of combustible.

The exact dimensions of the test boiler were as follows:

Diameter of drum, inches	0—42
Length of drum, feet and inches	10—03¾
Tubes, number, 560; outside diameter, inches	0—02
length, feet and inches	8—02
thickness No. 10 B. W. G.	
16; outside diameter, inches	0—04
length, feet and inches	8—02
thickness No. 6 B. W. G.	
16; outside diameter, inches	0—04
length, feet and inches	6—04
thickness No. 6, B. W. G.	
Furnace, single, full width of boiler.	
Grate surface, length feet	7—00
Area, sq. ft.	57.89
Heating surface, area, sq. ft.	2,571.39
Ratio to grate	44.4 : 1
Grate bars, kind (double)	U. S. Navy Standard Bar.
Width of air spaces, inch	0—00½
Ratio of grate to air space	1 : .427
Smoke pipe, area, sq. ft.	19.63
Height, feet	100—00
Water space, cu. ins.	301,561.0
Steam space, cu. ins.	102,889.0

The boiler was erected in a sheet-iron test house which could be closed fairly air-tight. Forced draft was supplied by a blower outside, which discharged into the test house at the floor line behind the boiler. The incoming air was deflected upward by a vertical baffle wall. In addition, a steam jet was provided in the smoke pipe, supplied with steam from the main steam pipe, with a valve for regulating the opening.

Six test runs were made under the supervision of a board of United States naval officers, consisting of Commander C. W. Dyson and Lieut.-Commanders J. K. Robison and H. C. Dinger. The first four were 24-hour tests required by the contracts for the "Wyoming" and "Arkansas," at rates of combustion of 15, 25, 35 and 40 lbs. of coal respectively per square foot of grate per hour. The fifth test was a three-hour test for maximum capacity of the boiler.

The sixth test was made at the rate of about 45 lbs. per sq. ft. of grate per hour, to determine the effect of lowering the back end of the grate 6 ins. below the position in the previous tests. The effect was found to be so slight that it could not be determined satisfactorily whether any actual advantage or disadvantage resulted from lowering the grates.

Contract Requirements.

It was required that the tests be made continuously, except that a maximum time of two hours was allowed for cleaning fires after each 24-hr. test before beginning the next. The only cleaning of boiler tubes allowed was by steam or air lances such as are regularly used in actual service. The average air pressure in the fire-room at the highest specified rate of combustion (40 lbs. per sq. ft. of grate per hour) was not to exceed 2 ins. of water. The equivalent evaporation from and at 212° F. at this rate of combustion was required to be not less than 11 lbs. of water per pound of combustible.

The board reported that the test boiler fully met all requirements of the contract as to evaporative efficiency, and recommended the approval of this type of boiler for general use in the naval service.

Results of Tests.

The curves of evaporation rates, reproduced herewith, indicate a very small decrease in efficiency for increasing rates of combustion until a combustion of about 45 lbs. per sq. ft. of grate per hour is reached. The rate of combustion obtained in the maximum capacity test slightly exceeded 70 lbs. per sq. ft. of grate. This is high for marine practice, although a combustion rate of more than 100 lbs. per sq. ft. of grate is common in American locomotive practice and as high as 200 lbs. per sq. ft. is occasionally reached. The evaporation obtained in this maximum capacity run was 10.33 lbs. of water (equivalent, from and at 212°) per pound of combustible, giving an efficiency for the boiler alone of 63.25%.

The evaporation per sq. ft. of heating surface during this run reached the high figure of 14.76 lbs. per hour.

Number of test	1.	5.
Date of test	June 13-14	June 18
Duration of test, hrs.	24.06	3
Kind of fuel	Pocahontas, hand picked,	excellent.
Calorific value per lb. of combustible,	15,838	B. T. U.
Force of draft in furnace, ins. of water.	.16	4.70
Weight of coal as fired, lbs.	21,200	12,200
Moisture in coal, per cent.	.88	.75
Weight of combustible consumed, lbs.	19,752	11,073
Coal consumed per hour per sq. ft. G. S., lbs.	15.22	70.24
Coal per hour per sq. ft. H. S., lbs.	.343	1.581
Quality of steam (dry steam = 100)	100.	99.57
Steam pressure, gage, lbs.	202.	200.6
Temperature of feedwater	211.6	194.4
Total weight of water fed to boiler, lbs.	228,095	106,964
Equivalent water evaporated into dry steam from and at 212°, lbs.	239,956	113,853
Equivalent evaporation from and at 212° per sq. ft. G. S., lbs.	172	656
Same per sq. ft. of heating surface, lbs.	3.88	14.76
Equivalent evaporation from and at 212° per lb. of dry coal, lbs.	11.42	9.45
Equivalent evaporation from and at 212° per lb. of combustible, lbs.	12.15	10.23
Efficiency of boiler; heat absorbed by the boiler per lb. of combustible divided by the heat value of one lb. of combustible, per cent.	74.39	63.25
Efficiency of boiler, including grate; heat absorbed by the boiler per lb. of dry coal, divided by the heat value of one lb. of dry coal, per cent.	72.50	60.00
Kind of firing (spreading, alternate, or coking)	Spreading; fires level,	doors fired in rotation.

The chief results of the first test (maximum efficiency) and the fifth test (maximum capacity) are given in the accompanying table.

Lieut.-Commander Dinger states that the firemen employed were ordinary marine firemen picked up on the Hoboken docks, and concludes his paper with the following remarks:

> The firemen, while completely unskilled, so far as boiler firing was concerned, soon became very much interested in the results of the gas analyses, and learned the value of so firing as to maintain as high a percentage of CO_2 as possible. This interest manifested itself very early in the tests, in the decreased density of the smoke escaping from the stack.
>
> Particular attention is called to the excellent results obtained with this boiler under the maximum rate of combustion obtained, which slightly exceeded 70 lbs. of coal per sq. ft. of grate per hour. The boiler under this condition steamed very freely, with no appreciable increase in the wetness of the steam, while the falling off in efficiency under all test conditions, from the lowest rate of combustion to the highest, was small and very regular.
>
> After the completion of the tests the boiler was opened, cleaned and thoroughly inspected for deterioration. Not a tube showed any signs of distress, all tubes and headers were perfectly free from blisters and all baffles were still properly placed. This result would seem to indicate that when a boiler of this type is clean, free from scale, and built of proper material it is perfectly safe under all regular rates of combustion, up to the highest rate to which it was subjected in these tests. This finding, necessarily, supposes intelligent supervision and proper regulation of feed water during such rates of combustion.

An Italian Three-Phase Locomotive.*

The condition of the atmosphere in the Giovi Tunnel, between Pontedecimo and Busalla on the line between Genoa and Milan, several years ago had become so bad that a desired increase in the number of trains or steam locomotives could not be made without danger to the service. The traffic on this line is very heavy, as it is the most important line between the port of Genoa and the greatest manufacturing center of Italy, Milan. There is a heavy coal traffic in addition to the general passenger and freight business. The artificial ventilation could not be improved, owing to the length of the tunnel, and the Italian State Ry. adopted the system decided upon for the Valtellina and Simplon lines, 3,000-volt, three-phase, 15-cycle. The first order of 40 locomotives was given to the Italian Westinghouse Co., of which 25 were for the Giovi line and 15 for the Savonna—San Giuseppi between Savonna and Turin. The first locomotives were completed in 1908 and were used on the Valtellina line pending completion of the line construction in the Giovi tunnel.

It is interesting to compare the main features of the latest Valtellina locomotives (built by the Ganz Electric Co., of Budapest) with the latest ones for the Giovi line. It should first be recalled that the Ganz Valtellina design weighed 62 tons, with 42 tons on the drivers. There were two motors—one an 8-pole, 1,500-HP., and the other a 12-pole, 1,200-HP. type. Three running speeds, of 16, 26 and 40 mi. per hr., were obtained by running the 12-pole motor in cascade with the 8-pole, by the 12-pole motor alone, and by the 8-pole motor alone, respectively. The change switches were operated by pneumatic valves. Intermediate speed ranges were obtained with a water rheostat in which the electrodes were fixed and the water level was varied by air pressure according to the position of a second control handle. The height of water level was made to depend on both air pressure (determined by position of the control handle) and rotor current so that each position of the handle indirectly corresponded to a certain current which was automatically kept constant. By this scheme two locomotives of unequal wheel diameters could be used together with any desired adjustment of the load between them.

The new Giovi locomotive is built for freight service, but it can be used for passenger trains, as its speed capacity is as high as is considered safe for the line. There are only two running speeds, 28 and 14 mi. per hr. The former

*In part from information supplied by the Westinghouse Electric & Manufacturing Co., Pittsburg.

for normal operation and the latter for switching and for regenerative braking on down grades. The locomotive weighs about 60 metric tons, (66 tons of 2,000 lbs.) but it can be ballasted to 75 metric tons for greater adhesion. Provision is made in the frame construction for bolting on cast iron weights for the added ballast.

During recent tests, a train of 318 metric tons, exclusive of locomotives, was taken with a speed of 28 mi. per hr. from Pontedecimo to Busalla, a distance of 6½ miles with a maximum grade of 3.5% an average grade of 2.70%, and a minimum curve radius of 1,200 ft. After this the train was taken back at a speed of 14 mi. per hr. the locomotive motors being connected for braking power. The time allowed for one round trip was 140 minutes. After 20 hours of continuous operation, one round trip without forced ventilation of the motors was made with a temperature rise of the motors considerably less than 75° C. The required one-hour motor rating for the same temperature is 720 HP. per motor; during the test this was exceeded. The friction rating under most unfavorable conditions is such that a train of 380 metric tons, exclusive of the locomotive can be accelerated to 28 mi. per hr. in less than 200 seconds, by two locomotives, one pushing and one pulling, on a grade of 3.50% and on a curve of not more than 1,200 ft. radius. One locomotive can accelerate a train of 400 metric tons (without locomotive) to a speed of 14 mi. per hr. on a grade of 0.3%, and 300 tons on a curve of 540 ft. radius 30 times in one hour. The maximum starting torque is such that the motors can slip the wheels of the locomotive, with its weight increased to 75 tons, while the locomotive is kept stationary. The entire weight is on the ten drivers which are carried by one truck. The drivers of the middle axle are without flanges. The end axles have a transverse play of 15 mm. (0.59 in.). All drivers on a side are driven by a Scotch yoke connecting the cranks of the two motors. The rigid wheel base is 12 ft. 7 ins., and the total wheel base 20 ft. 1 in. The length over all is 31 ft. 2 ins. The two outer axles on each end are loaded by a pair of leaf springs carried between the axles; the middle axle is loaded by a single pair of springs. This forms a six-point support.

The motors are three-phase, 3,000-volt, 15-cycle machines arranged to run in cascade and parallel, giving two synchronous speeds of 112½ and 225 r. p. m., intermittent speeds are obtained by inserting rheostats in the rotor circuits. The motors have double bearings, the outer of which is bolted to the main locomotive frame and carries the reactions of the frame; it also takes the thrust of the connecting rods and is provided with springs to take up all the motion or changes of position due to shocks, ballast on locomotive frame, etc. The stator carries the inner bearings which have for their function only the maintenance of air gap. The rotor itself is entirely independent of any motion of the locomotive frame. The stator weight is borne by a frame which is spring mounted in the locomotive frame in a way to have free movement vertically and transversely, within certain limits. This mounting allows the stator to follow any movement of the rotor and the maintenance of an air gap of 2 mm. (0.078 in.). With no weight on the inner bearings there is practically no wear.

The motor secondaries are designed for low voltage which is necessary (1) for connecting the motors in cascade, (2) for having a low potential on the slip rings of the rotor, and (3) with the starting resistance in a water rheostat. The water is in a tight tank mounted so as to extend below the cab for air cooling. Electrode compartments extend from below the water level, through the cover and up into the lower parts of the locomotive, the electrodes being supported in the upper portions of these cylinders. In operation the height of water in the compartments is regulated by air pressure. The regulating mechanism extends into the cab proper and can be conveniently inspected after the removing of a protecting cover.

The motor-changing switch is the only mechanism of the system having numerous contacts for heavy currents. Since it is operated without current the care and expense of maintenance is reduced to less than 10% that of the other switches. It may be operated by only two relays while the other switches are under master-switch control and require relays for all taps. This motor-changing switch is also mounted directly on the motor to save wiring. The switch mechanism extends into the cab from below and may be inspected easily by removing a protecting cover.

The only switch that is normally worked under current is the primary switch. Even for this, switching conditions are made very favorable. The current to be interrupted in the primary of induction motors with wound secondary may be reduced practically to the magnetizing current, by first inserting resistance into the secondary. Then breaking the primary current involves no trouble. The switch also serves as both an interruption switch and a reversing switch without requiring any additional contacts for the reversing; this is accomplished by simply rotating the movable contact parts through a certain angle in order to reverse the motor.

All contacts that have to be operated under current in the secondary or rotor circuits are eliminated, excepting the one contact which short circuits the rheostat. On this contact, however, there is no arcing and burning, since it operates only when the water resistance is very low.

The master-switch is arranged with two levers. One of the levers has four definite positions corresponding to the two speeds, forward and backward. The second lever regulates the current consumed by the motors. Every position of this lever determines positively the certain maximum current to be taken by the motors; any time the motor tends to draw a current larger than that corresponding to the lever position, resistance is automatically inserted into the secondary. This lever acts on the armature of a small induction regulator and thereby regulates the secondary potential of the regulator; the induction-regulator secondary is connected to one coil of a relay, movement of which is counteracted, by a second coil, the current in which is proportioned to the motor current. Whenever the effects of the relay coils are balanced the armature is in the middle and the motor currents remain unchanged; as soon as the motor current increases the armature is attracted by one coil to close the relay circuit, which operates the water rheostat and increases the resistance in the secondary. As each locomotive can be set for a maximum current it is possible to use the locomotive in multiple without a special multiple control; nevertheless, a multiple control arrangement is provided for. Such a control system not only permits the operation of locomotives, of different wheel diameters in multiple, equally loaded but also permits distributing the load in any desired ratio. This is of advantage where it is frequently desirable to keep the drawbar pull of the leading engine within certain limits and to make the pusher carry the greater part of the load. For this multiple control a train-line cable has to be carried from the forward to the rear locomotive.

The master-switch control is electro-pneumatic and the magnets operating the switch valves are designed to work on half normal voltage.

The pantagraph collector is a simple design having a single bow with two bronze cylinders, insulated from each other and revolving in ball bearings. These make contact with the two overhead wires necessary for three-phase running. The use of rolling contacts have been found very successful on the Valtellina line where it has been in use for ten years. Here the rollers are changed after an average running of 15,500 locomotive miles (not counting shunting service). On the Simplon line, where sliding contacts are used, it is reported customary to change contact pieces for each 1,680 locomotive miles. This great difference is explained by the fact that the contact point on the roller changes so rapidly that no part becomes heated to the melting point of the metal.

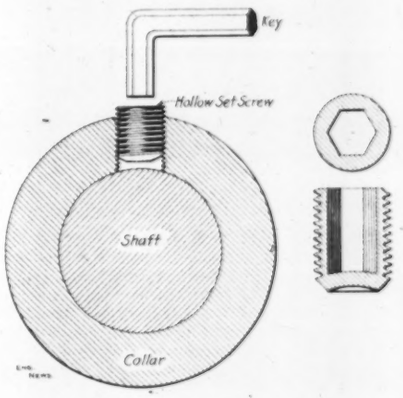
These Giovi locomotives were built at the Vado Ligore works of the Italian Westinghouse Co., and all apparatus used on them is of Westinghouse manufacture.

Hollow Safety Set-Screws.

The type of set screw in general use has a square head to which an ordinary monkey wrench or end wrench can be applied. Set screws of this type have to be kept in stock in a variety of lengths of each diameter, for use in collars or hubs of different thicknesses. This is an inconvenience, but it is not so serious an objection as the danger arising from the projection of the set-screw head beyond the collar or hub. The projecting head, with its sharp corners, is well suited to catch the sleeves of an incautious workman. Fatal accidents have been caused in this way.

Headless set screws are sometimes used, in which the square head is replaced by a screwdriver slot. But such screws, except in the smallest sizes, cannot always be made to bear tightly enough against the shaft, and set screws must often be placed where it is is hard to get at them with a screwdriver.

The hollow set screw, shown in the accompanying illustration, is driven by means of a hexagonal key, or wrench, which fits the hexagonal hole of the screw. This puts very little torsion on the screw, and it may therefore be set



Warman Safety Set Screw.

as tightly as desired. In the cup-pointed set screw, the pressure is applied not far from the outside edges, so that the hollow screw, with cup point, is practically as strong as a solid one against end thrust.

The form of the wrench permits the hollow screw to be used in a hole of any reasonable depth. This means that only one length of screw of each diameter need be kept in stock and can be used in hubs or collars of any thickness. In deep holes, two screws can be used, one on top of the other, which will lock them both in position. There would often be a likelihood, where one of these hollow set screws was used at the bottom of a comparatively deep hole, that dirt, metal chips or rust might foul the exposed portion of the hole. It is suggested, however, that the hole can be filled with beeswax.

The set screw shown in the illustration is the invention of Wm. A. Warman, of Rochester, N. Y., and was patented by him Aug. 6, 1901. These screws are made at low cost from round disks or buttons of sheet steel. The disks are drawn to the hollow cylindrical shape by a series of punches and dies. The last punch of the series has the hexagonal shape required for the interior of the finished screw. The thread is cut after the shell has been formed. Only U. S. standard thread is used. These screws are put on the market by Hammacher, Schlemmer & Co., New York City.

A screw of very similar appearance was brought out by the Allen Mfg. Co., Inc., of Hartford, Conn., in June, 1910. It appears to differ from the Warman screw in being made from bar steel. Superior strength is claimed. The list prices of the Allen screws are about 50% greater than for those of the Warman type. The Allen screws can be made from punchings commonly sold as scrap which can be obtained at a very low cost.

A New Dump-Car With Inside Journal Bearings.

In railway construction and other work where large quantities of excavated material have to be handled, extensive use is made of large side-dump cars which may be operated on either construction tracks or main tracks. A car of this type which has been introduced lately has several special features in its design.

A general view of the car is shown in Fig. 1, and the most noticeable feature is the absence of outside journal boxes. The trucks are of the arch-bar type, but with inside journal bearings, thus avoiding the breakage of outside boxes by the material falling from the cars or by the boxes striking dumped material which has not fallen clear of the car. It is stated that owing to the height at which the body is set there is plenty of room to work inside in renewing brasses or packing the boxes. It is claimed, also, that with inside bearings there is less liability of derailment when running over rough track. Another feature of the car is that the body will tilt to a very steep angle (49°), thus ensuring the clear discharge of all material. The body is set at the usual height, but the steep slope is accomplished by the use of a special form of pedestal and hinge casting, shown in Fig. 2; each of these parts is a single piece. When the car tilts, a horn on the hinge casting (as at A, Fig. 2), takes a bearing upon the pedestal, so that the point of support is shifted from the center line to the dumping side. The horn is formed on a web, B, which moves in a slot in the pedestal and so holds the hinge in position. The car body is raised slightly on this bearing by the momentum of the load; in this position it is so lightly balanced, with the hinge casting clear of its seat, as at C, that it will right itself when the dumping cable is slackened by releasing the air from the operating cylinder.

The body is supported on six center pedestals, and when the car is running the body is held on each side by two chains attached to the trucks. With chains rigidly attached to the body and truck, the jerking and swaying of the loaded body might lead to fracture of the chains; to prevent this, the chains are anchored to the truck below the springs and the shocks are thus relieved by the cushion effect of the springs. The side doors swing upward as the body tilts so as to clear the falling load. They are designed especially with a view to strength and ready repair, as they are liable to be broken or damaged by boulders or by the steam-shovel bucket. The planks forming the door have their ends fitted to sockets in end castings, while between the edges of adjacent planks is fitted a longitudinal steel T bar which extends the full length and is engaged by the end castings and center bracket. The door is stiffened also by an outside center panel or batten which is about one-third the length of the door. This not only strengthens it against breaking, but acts as a spring to resist bulging. Finally the door is trussed by steel rods, the truss depth being about 7¾ ins.; no clevises are used, but each rod is held independently by nuts at the center and end castings. Right hand threads are used on all rods.

The center sill is composed of a pair of 15-in. steel channels, between which is fitted the draft rigging. No rivet holes are made in the bottom flanges of these channels (subject to tension strains), all attachments being made on the web or top flange. Each body bolster is a single steel casting of triangular form; and of unusual depth in order to secure stiffness. The horizontal member passes under the sills, while the inclined members have projecting arms on the inside which are riveted against the webs of the sill channels. The bolsters are of I-section, and each has formed with it the center plate, two side bearings, and two pockets for coiled springs which take the shock of the body as it reaches the dumped position.

The dumping is effected by two horizontal air cylinders, one for each side. To the crosshead of the piston rod is attached a cable which passes around guide sheaves and has its other end attached to the body of the car. The dumping is controlled from the engine cab. The hose pipes are coupled up on whichever side the dumping is to be done; or if it is desired to dump on both sides, the hose are crossed, so that alternate cars will dump on opposite sides.

In the design, particular attention has been given to the two features of strength in construction and facility of repair. Rolled steel shapes, forgings and steel castings are used principally. The wheels, axles, brasses, couplers, [illegible] rigging and other equipment are made to conform to the M. C. B. standards. The chain [illegible] door and dumping iron pins, etc., are [illegible] and loose fitting, being held in place [illegible] pins at each end. This facilitates the [illegible] in either direction if they become bent or distorted. Hose connections and brake and coupling gear are protected from falling material, being housed under the body or covered by shields of forged steel. The cars described above were designed by the Fitz-Hugh, Luther Co. of Chicago, and are built at that company's shops. Those of the first lot are now in service. The car weighs about 24,000 lbs., and has a carrying capacity of 12 cu. yds. or 50,000 lbs.

FIG. 1. DUMP CAR HAVING A STEEP DUMPING ANGLE, AND MOUNTED ON TRUCKS WITH INSIDE BEARINGS.
(The Fitz-Hugh, Luther Co., Chicago; Builders.)

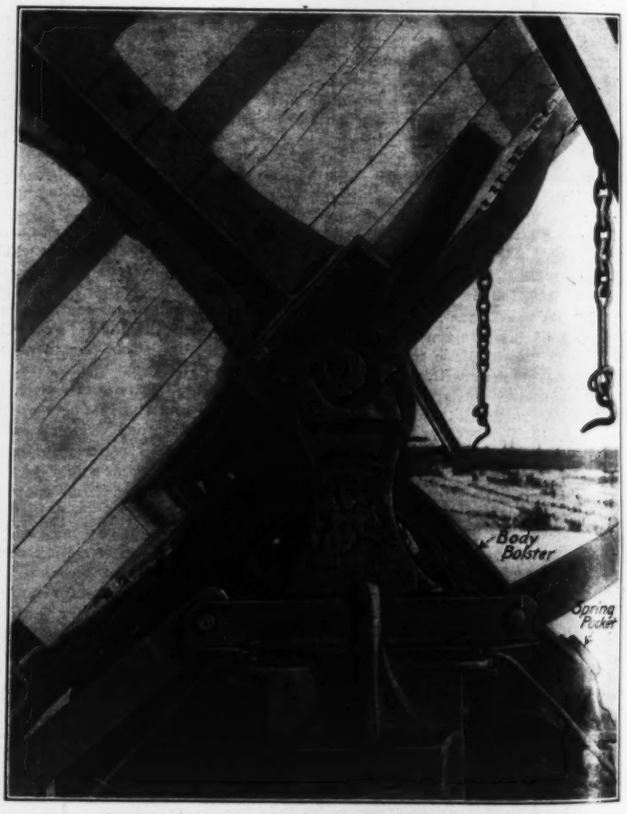


FIG. 2. PEDESTAL BEARING OF DUMP-CAR BODY.
(In dumping, the point of support is shifted to the side, giving a steep angle of dump.)

A STORAGE-BATTERY RAILWAY CAR has been used on the West Orange branch of the Erie R. R. between West Orange and Forest Hills, N. J., for suburban service during the hours of the day when traffic is light, to connect with steam trains. Data on the operation of this car since Nov. 14, 1910, is given in the April issue of the "American Engineer and Railroad Journal." It appears that the car was used as an experiment, being a prepayment street-line type not designed especially for the Erie service. It is 28 ft. long inside of corner posts and 7 ft. 6 ins. wide. The platforms are 6 ft. 1½ ins. long, making the car 40 ft. 3 ins. long over all. It is built of steel—I-beams, channels and sheets—throughout with an arched roof in place of the older monitor type. Maximum-traction trucks are used, of peculiar construction. Each driver is independently driven, by chain, from a 10-HP. motor fitted with ball bearings. The wheel axles do not revolve, each wheel being independent of any other. The axles are chrome-steel I-beams, forged with 3¾-in. end pieces which are slipped into the wheels (hub roller bearings). The truck contains no bolts or rivets, being welded together by an oxy-acetylene process. The car, with a storage battery of 180 Edison A 8 cells, weighs about 30,000 lbs., or 725 lbs. per passenger.

A test run of 18 miles has been made on an hour's charge of the battery, during which the power consumption averaged 0.625-KW.-hr. per car-mile, or 0.043-KW.-hr. per ton-mile. At 2 cts per KW.-hr. this would amount to 1.25 cts. per car-mile and 0.08 ct. per ton mile. The maximum speed attained on this test was 32 mi. per hr. with an average speed between stops of 25 mi. per hr.

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ADVERTISING

"Contract": Rates furnished on application.
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Entered at the New York Post-Office as Second-Class Matter.

The possible contamination of public water-supplies by defective sewers in close proximity to distributing mains is a subject which deserves more consideration than it generally receives. Elsewhere in this issue we publish an article on an outbreak of typhoid fever at Lexington, Va., which, after investigation by representatives of the State Board of Health, was attributed to the causes just stated. No particular comment on the general features of the outbreak seems to be required, but it does seem desirable to raise a question regarding the wisdom of scattering over the country students suffering from typhoid outbreaks in institutions. There were some 350 students in the Military Institute at Lexington when the outbreak occurred. These were dismissed on furlough and subsequently reports were received of twelve of the students sick with typhoid after going home. Would it not have been wiser to have kept the students under strict sanitary control instead of dismissing them to homes where, in case they came down with typhoid, the chances were great that in a considerable percentage of the cases proper sanitary precautions against the spread of the disease would not be observed?

Philadelphia has added itself to the list of cities which have conducted experiments on sewage treatment. The scope of the experiments and the conclusions drawn from them, as given in a report on the subject, are presented elsewhere in this issue, and will be followed with much interest, we are sure, by all engineers interested in this field of work.

The most notable new features of the Philadelphia experiments, as compared with those made elsewhere in this country, appear to be the experiments with the Imhoff settling and sludge-reducing tank, the Dibdin slate contact beds and the studies of the effect of various degrees of dilution upon sewage which had been passed through fine screens and disinfected with calcium hypochlorite.

The intention was to have carried the dilution studies further, and it seems particularly unfortunate that this could not have been done before the experiments were brought to a conclusion; but the report holds out the hope that further experiments along this line will be made.

Most of the filter units tested were small. The ordinary sedimentation tanks were on a larger relative scale, and the tank used for studies of dilution was of considerable size. The Imhoff tank was small, but lacked more in depth than in diameter. It is fair to assume that a better-proportioned Imhoff tank would have shown results even more favorable than those which were obtained. The results obtained, however, were confirmatory of favorable reports from abroad.

It seems pertinent to inquire why a city with such facilities for sewage disposal by dilution as Philadelphia possesses should have gone into so extensive a series of experiments with other methods of disposal. It certainly seems as though it would have been far more to the point to have reversed the relative attention given studies of dilution and the more generally accepted methods of treatment; or perhaps we should say that it would have been very desirable indeed to have subjected to the dilution tests effluents from each of the main processes with a view of determining the minimum preliminary treatment required before the disposal of Philadelphia sewage by dilution. On the face of things, the bacterial purification of Philadelphia sewage, whether by disinfection or otherwise, seems to be unnecessary.

It may be well to state that Philadelphia did not enter upon these experiments wholly of its own volition. Like Pittsburg, which is somewhat similarly situated as regards possibilities of sewage disposal by dilution, Philadelphia has been ordered by the State Department of Health to submit comprehensive plans for the purification of the sewage of the whole city.

Of the wisdom or necessity of such an order in such a case, we are yet to be convinced. In our opinion, the first thing which should be investigated in each of these cities is whether or not any method of sewage purification other than screening and possible brief sedimentation, can reasonably be demanded of them for many years to come, in view of the other sanitary needs of the two cities. Pittsburg has already taken up studies from this point of view, if we are correctly informed, and possibly the Philadelphia officials have the question under consideration.

We are well aware that the orders of the Pennsylvania Department of Health do not obligate either city to install purification works at any specific date, and that the general object of the Department is to put these and other municipalities in the state under central sanitary control as regards future means of sewage disposal. Nevertheless, we think the consensus of opinion among outside engineers competent to pass judgment is that the Pennsylvania Department of Health is already demanding too much, and shows evidence of intending to be still more unreasonable in its future demands, regarding municipal sewage disposal.

Engineers the country over cannot fail to have a special interest in the announcement that those responsible for the long series of dynamite outrages, occurring in the past three or four years, have been found and arrested.

As many of our readers know by bitter experience, these dynamite explosions have generally occurred in connection with structural steel work under erection with non-union labor.

When these dynamite explosions began, those who perpetrated them apparently took some pains that in injuring the contractor against whom they sought revenge other property should not suffer or lives be endangered. They operated only against unfinished structures to which the public did not yet have access, and they did their work in the night.

It is only a few short steps, however, from such anarchistic work as dynamiting an unfinished bridge or a hoisting engine to blind attacks on all property and to wholesale murder, and the movement in that direction has been evident. In recent months bridges have been dynamited after completion when about to be turned over to the public, and in a few cases the attacks even involved structures already in public use.

In our issue of July 28 last, we pointed out that this dynamiting conspiracy was becoming so serious that it promised to cause the sacrifice of many innocent lives, and that it should not be regarded by the public as merely a fight between labor-union men and employers in a certain industry.

In the weeks that followed, shop buildings and various parts of industrial plants or contractors' property, not always in cases involving ironwork, were destroyed by dynamite; and, worst of all, a newspaper building in Los Angeles, filled with people, was blown to pieces, although no contractor was even remotely interested.

It has been claimed, indeed, that those who conducted the dynamite campaign against non-union contractors did not engineer these later outrages, and it has been attempted to prove that the Los Angeles disaster was due to a gas explosion. Those are matters which may be safely left to the courts to determine. The fact which is of public knowledge is that the dynamite injuries to structural steel work were carried on for years over a wide extent of territory and were directed against employers who had been involved in difficulties with labor unions. It is only logical to conclude that these explosions were the result of an organized conspiracy.

To trace that conspiracy to its source and break up the gang engaged in it is a work for law and order, for public safety and for the benefit of all, rich and poor, employer and workman, which it would be difficult to value too highly.

To-day and To-morrow.

Planning for public improvements brings up in each instance a vital question: How much burden should be put on the present generation, how much left for posterity to carry? The financial phase of this important question is the one usually alone considered. There are other phases, however, that frequently assume an equal or greater importance.

Short-time or temporary improvements are, of course, not at issue. As regards their financing, they are mere items of current day-to-day expense and obviously must be paid out of current income. It is true, there are cases where such ephemeral expenditures as supplies and temporary betterments have been bought on notes and bonds left to be settled a quarter century in the future, but individual instances of such practices do not alter the general principle. No sane and honest person would countenance issuing 50-year bonds, for example, to pay for 10-year pavements. So also the nature of the construction or improvement itself in the case of mere temporary improvements does not greatly concern the future generations. Being of short life, the structures concerned will disappear or be replaced by others before another generation.

But in the case of permanent or long-time improvements the situation is otherwise, both as regards financing and as regards the nature of the construction. In the matter of financing it often becomes a weighty question how far it is proper to extend the burden of capital charge. Fortunately, this problem in a measure determines itself, since usually the bonding of corporations or public bodies finds various limits long before it could reach the limit which theoretical discussion might establish. Custom and good sense unite in forbidding bond issues that run too far into the future. And refunding also is subject to limitations, since each generation feels only too strongly the hampering restriction of the old-inherited debts of generations long since dead.

But the problems other than financial which are involved in permanent and long-time improvements do not usually carry their own answer, and they are therefore apt to be the more serious. These are the questions of the physical burdens saddled by one generation on the back of coming generations. When a city plans a great park system destined to mark its map permanently, or when storage dams or great canals are established; in short, in all cases of what

we may call wholly permanent construction, there is created not only a value which persists independent of physical decay, but also by the establishment of fixed physical conditions a limitation is placed upon freedom of action in the future, which may turn out to impose a burden on our successors. To a large extent the same thing is true of constructions not strictly permanent, but yet destined to endure and presumably to serve for a long time. The laying out of street-car lines, the construction of water-supply or sewer networks—indeed, almost all works of public service and innumerable private works having only incidental public relation—carry the possibility of creating future hampering limitations, or even more directly sensible burdens This is a field where foresight and broad consideration of public needs and conveniences must be exercised, and the responsibility in most cases is upon the engineer.

A good example of the question of the future entering into matters of present construction appears in the planning of urban rapid-transit lines. In the larger cities where street cars are unable to provide for the needs of through transportation, and where the existing steam railways are not so located as to be able to care for it, overhead or underground rapid-transit lines become necessary. The advantage of cheapness is always with the overhead railway; in other respects the underground line is distinctly ahead. The crucial question then arises, how shall the balance of cost and service value be struck in order that the proper decision may be reached as to which of the two plans shall be adopted?

In New York City, the authorities have been in a turmoil for half a decade or more over questions surrounding the construction of new rapid-transit lines which are badly needed to meet the demands of traffic. The many differences of opinion on the situation contain as one important factor the question whether underground or overhead construction should be the chief means of providing rapid transit. The corporation which operates the present rapid-transit routes in the principal borough of the city has insistently demanded authorization to extend its elevated railways in the most heavily populated sections, and also in those sections where immediate extensive development is in prospect. By persisting in the attitude that it would undertake no further underground construction until the permit for elevated extension was granted, it has created a situation in which it is likely to succeed in its demand. The public authorities, while in the main not favorable to further elevated construction, took this attitude largely for esthetic reasons. No thought appears to have been given to the measure of responsibility involved in passing on to succeeding generations the fixed burden of established elevated railways.

Experience in the borough of Manhattan of New York City is most illuminating as to the heavy losses imposed upon the city, and upon the public as individuals, by the elevated railways. The existing four longitudinal lines of elevated railway inflict serious injury on the streets through which they run and on a narrow belt along either side throughout their length. The habitation value of these streets is enormously reduced, and renting values suffer in consequence. The burden of noise, dirt and reduction of light has many minor influences beyond this. To the unprejudiced onlooker these four railway lines are a most convincing argument against permitting a single foot of further elevated railway construction in the closely-settled parts of the city. The municipal authorities, in their consideration of the problem, have doubtless been influenced by this fact and have weighed against the gain of economy by elevated construction the losses to which the present generation would be subjected. But they have not, we feel sure, given proper thought to the fact that the burden would be imposed not only upon the present, but in perhaps even greater degree upon the future.

There can be no doubt that the decision at a time fifteen years from now, or perhaps even sooner, will be single-voiced against elevated construction and for underground construction; and that the next generation will be entirely ready to assume the greater financial burden resulting from subway construction in return for being spared the lasting disability which elevated railways would create. In view of the fact that the financial burden will fall upon the future generations in any case, and not upon the present generation, there would seem to be no doubt as to the decision which should be reached now.

The influence of the future upon construction of the present time, as it appears in the instance cited, may be found equally well in a multitude of other constructional problems. There is a clear obligation on those who plan public improvements to plan for the future as well as for the present. It is only too common to find that the planning for the future consists in nothing more than pleasant contemplation of how the benefits of the construction will inure to the good of our children and our grandchildren. The broader consideration of the matter, however, will give attention not only to the benefits but also to the limitations and burdens which the work of to-day imposes upon the future.

Work for Engineers in Connection With Public Service Commissions.

One of the most remarkable features of state legislation during the present year is the enactment in numerous states of laws creating public service commissions, modeled generally on the Public Service Commission Law of New York. When such states as New Jersey and Pennsylvania and California, in which the state government has for years been well understood to be under control of the great railway interests, enact laws putting railways and all other public service corporations under control of commissions, with broad powers to fix rates and regulate service, the fact is one of great significance.

It is worth while noting, too, that this nation-wide movement for state regulation of public utilities follows closely after the sweeping legislation enacted by Congress less than a year ago, increasing the power of the Interstate Commerce Commission and establishing a new Commerce Court with broad powers over railway corporations.

These public events are a strong commentary on the narrow point of view of those railway officers who, during the past two or three years, have thought to stem the tide which is setting towards state control by conducting a counter-agitation with the war-cry of "Let us alone!" Events have demonstrated beyond a doubt that the public will not let the railways and other public utility corporations alone. On the contrary, there is a well-nigh unanimous public demand that effective control of such corporations shall be established.

This public demand results primarily not from agitation by any one man or set of men, or by any political party or faction. Such men as Ex-President Roosevelt and Senator La Follette, of Wisconsin, and Governor Wilson, of New Jersey, with the so-called insurgent element in each of the great national parties, have indeed been instrumental in focusing public attention upon the issue of corporation control; but the impelling force back of this demand is the change in economic and business conditions. Business men of all classes have found by experience the necessity for their own protection of establishing some measure of public control over the great transportation systems and the monopolies which control the distribution of necessities in cities.

It is fair to say that many of the leading railway officers have recognized this inevitable trend and have not fought the legislation establishing public service commissions as it would have been fought by the corporate interests a dozen or twenty years ago.

They have been wise in this course, not only because the movement is, we believe, inevitable, but because there is far more hope that the railways and other corporations will receive a square deal when regulated by able commissions, properly organized, than when [illegible] regulation is left to the caprice of legislation.

It ought to be recognized that if railroad corporations have owned state legislatures in the past, they have not seldom had the excuse that it was necessary to acquire such ownership to protect themselves from blackmail. But securing ownership, however, it was not to stop, and some of the acts passed by such legislatures, after their purchase at the direction of their owners, have had much to do in bringing about the present public demand for effective state control.

The question of absorbing public interest at the present time is how these new public service commissions which have been created in many states can be made really effective to secure the ends sought in their establishment without committing blunders and injuring the interests under their control in a manner which will inevitably react upon the public at large.

To enact a good public service commission law in any state is only the first step. If good results are to be secured from the law it is equally important to select the right men to organize and carry on the work of the commission. Experience has fully demonstrated that if this work is to be done successfully it must be done by experts. Much of the success of Massachusetts, which has led all other states in its supervision of public utility corporations through state commissions, has been due to the fact that men of large ability were obtained to serve on such commissions, and particularly men with expert knowledge of the business. The success of the Public Service Commissions established in the State of New York under Ex-Governor Hughes has likewise been due to the creation of a staff of experienced engineers, able to bring expert knowledge to bear on the matters under jurisdiction of the Commissions.

It may be frankly admitted that it is not every engineer, by any means, who is fitted by temperament and natural ability to fill such positions with credit to himself and to his profession. An engineer must add to his technical knowledge a fair measure of understanding of legal matters, of economics and of the general problems of administration. He must be a man able to reason soundly and to impress his views on those with whom he is associated. If the new Public Service Commissions, instead of being made up solely of lawyers, as is apt to be the case, can have in their membership a certain number of engineers of this type, the result will certainly be to the public advantage.

The fact is worth emphasizing that this new policy of public regulation is not only full of opportunities for public benefit, but also full of dangers to public welfare. There is a strong tendency to interfere too much with the management of our railways. There is a strong tendency also to subject railways to additional expenses which will not produce public benefits proportionate to the outlay involved. Such mistakes by public bodies are made often with the best intentions, but through ignorance of the real situation. The only way we see in which such mistakes can be avoided is through having the control in the hands of those who have the experience and the ability to deal with such questions wisely and fairly.

We have said that engineers with proper qualifications should be appointed to membership on Public Service Commissions; but it is a fair question to ask how the state executives, on whom the responsibility is generally and properly placed of appointing these Commissions, can be made to understand the importance of selecting engineers for membership upon them and can be assured of the competence of engineers who may be recommended to them. There is a reason why appointments to such commissions almost inevitably gravitate to lawyers, who have become known in public life often through political action, and who are often recommended for appointment by organizations of more or less responsibility. The engineer, however, is generally unknown; or, at best, it is only his technical qualifications that can be certified to, so that even if an engineer is recommended by some of his friends, there is more or

less doubt by the appointing power as to his real competence to fill the position.

It seems to us that this is a situation in which the only hope for proper recognition of the engineer must come through the action of engineers themselves, associated in their professional organizations. It may be admitted that engineering societies both national and local, as at present organized are seldom competent to give very valuable advice as to the proper men to be recommended for such positions as are here referred to. But this is not a final answer to the question.

If it be admitted that the proper function of engineering societies is to do for their members what individual members cannot do for themselves; if it be admitted that the road to advancement for the engineering profession as a whole lies through the organization of engineers to higher positions through more technical specialties—if these things be admitted, then it follows that engineers ought to have professional organizations which could take these responsibilities in connection with matters of this sort.

LETTERS TO THE EDITOR.

Wanted: A Substitute for Persian Wheels for Irrigation Work in India.

Sir: Will you kindly put me in communication with the proper firms for the following items:

Persian wheels are largely used in India by cultivators, but they are all of the old pattern, entirely of wood, with earthen pots for buckets. Has any improved pattern ever been manufactured by any firm?

Are small pumping plants built for raising water from wells for irrigation? The engine should be very simple in construction, and if possible should use firewood and cactus for fuel. The capacity should be the same as two bullocks working a Persian wheel.

A. M. Talati,
Dehra Dun P. O., India.

March 19, 1911.

[When India appeals to America for an improvement on the Persian wheel, which has been an established machine in Eastern irrigation for 5,000 years or more, the fact is surely worth especial notice. The American windmill and pump ought to give a good account of itself under such conditions, we should think; and if a steam power plant is required, the pulsometer vacuum pump with a low pressure boiler ought to commend itself by its simplicity and ability to handle muddy water without injury. Possibly a Rider-Ericsson hot-air engine would meet the requirements. Its advantages in requiring no boiler and in adaptability as to fuel should count for something under these conditions.—Ed.]

Ignorant Land Surveyors and Their Errors: Where a Licensing Law is Needed.

Sir: Although the idea of licenses for civil engineers has met with little approval, every conscientious engineer and surveyor will admit that some steps should be taken to regulate the practice of the land surveyor.

Men absolutely ignorant of the simplest theories of surveying, and many of them as careless in their work as they are ignorant of its theory, carry on an unrestricted practice all over the country. Mistakes that would seem ridiculous, if they were not so serious, are caused in almost unbelievable numbers by this free rein allowed surveyors; but the pity of it is that these mistakes, unlike those made in construction, show up, in the majority of cases, too late to affect the men who make them. A survey, good or bad, once made, and recorded, will often stand for years before its accuracy is questioned.

These mistakes have been the cause of many troublesome lawsuits, besides the trouble and inconvenience they cause the men who in time are called upon to resurvey the tracts; and these resurveyors may or may not correct the errors, depending upon their abilities and on the confidence they have in themselves and their work. As is often the case a resurvey proves the original work incorrect, but the surveyor, lacking in either care and competence or confidence in his own work, is timid and loath to change the original records; this timidity prompted mainly by fear that his own work may be incorrect. The result is that the original erroneous survey, is assumed by him as correct or "good enough" and the error remains uncorrected. Such conditions do exist, particularly in parts of the South and Southwest where any man who can read north on a compass is eligible for the job of County Surveyor.

I have met a number of surveyors in the two and a half years I have spent in this section, and have had opportunities to observe their work and its results. The ignorance many of them are in of the work they are called upon to perform is astounding, still they make a bluff at it and their work is taken as correct, which is perfectly natural as there is no one to check it and prove it wrong.

To illustrate: I had occasion to observe a unique method used by a County Surveyor, then four years in office, of calculating areas. A large plot of trapezium shape, the opposite sides greatly differing in length, was measured and the opposite sides averaged and multiplied together to arrive at the acreage. This same man can use neither transit or a level, still he passes as County Surveyor and City Engineer of a modern town of 5,000 inhabitants.

My attention was once called to a dishonest piece of work. A surveyor was bribed to run a line in such a manner that a well and reservoir would fall on his employer's side of the line. This was in canyon country where water is scarce and a good well is valuable. The line run was a long one, monuments were established and other lines later located from them. A murder was attempted and a lawsuit is now in progress as the result. In the interval the man who made the first survey has died.

A certain County Surveyor, who holds the office of Secretary of a state Engineers' and Surveyors' Society, recently organized, has taken up the cause of licenses for engineers and surveyors of his state. He doubtless is counting on his secretaryship to exempt him from examination, as he knows absolutely nothing of engineering, his sole stock in trade being a knowledge of plane surveying, even understanding nothing of the principle of the stadia. Such instances as this belittle the profession and make it appear cheap.

The laying out of city additions and city surveying is, of course, a more important matter than the surveying of lands, and should be entrusted to no one but skillful and experienced men. However, the tendency in a great many places is to employ the man who will do the work for the least pay, with the same result that one gets when he employs a quack doctor or a shyster lawyer.

In resetting block corners on a city addition recently I found accumulative errors(in measurements that amounted to over 8 ft. in four blocks. The original survey was made by an engineer of fair reputation practicing in that city at that time.

In laying out an addition of 80 acres to the same city I checked the base of an adjacent addition and found that that base missed by 37 ft. a corner one-half a mile distant where it should have intersected.

Such mistakes as these are almost without end. It is time to remedy this evil and there is no better remedy than examinations and licenses for surveyors.

J. A. Guissinger.
2195 Beverly Road, Brooklyn, N. Y., April 18, 1911.

Defending an Engineer in Public Service.

Sir: I read the announcement in Engineering News of April 20 of the resolutions passed in commendation of Superintendent of Buildings Miller by the New York Chapter of the American Institute of Architects and the Joint Committee of builders and architects on city departments. You may like to know that similar resolutions were passed by the New York Society of Architects on April 17, as follows:

WHEREAS, harsh and unwarranted criticism and charges of incompetence have been published by newspapers and individuals against the present Superintendent of Buildings, in connection with the Asch Building fire, and

WHEREAS, contrary to these allegations of inefficiency the present Superintendent of Buildings has most diligently enforced compliance with the Building Code, especially as to those sections relating to stairways and fire-escapes, be it therefore

RESOLVED: that the New York Society of Architects condemns as unjust the attacks on the present Superintendent, Mr. Rudolph P. Miller, and holds him blameless of any responsibility or negligence in connection with the Washington Place disaster.

The action of the societies in coming to the defense of Mr. Miller is, in the writer's opinion, of considerably more than local importance, representing as it does a tendency toward united professional action where the public relations of the profession are involved.

"C. B."

New York City, April 22, 1911.

Who Invented Portland Cement?

Sir: I have seen several items in the papers recently referring to the original invention of Portland cement. There seems to be some discrepancy in the accounts.

According to the Association of American Portland Cement Manufacturers, the honor of the original invention would seem to belong to Mr. I. C. Johnson, of Gravesend, Eng., who is still living at the age of 100 years, for an official telegram of congratulation on passing his 100th birthday was sent him, Jan. 28, by the President of the Association, in which he was referred to as "the first manufacturer of Portland cement." In some of the references in the recent press, however, the honor is, on apparently good authority, ascribed to Joseph Aspdin, a bricklayer of Leeds.

Which statement is correct? This kind of cement is so widely used at the present day, that I am sure an account of its early history would be of great interest to the readers of your paper, particularly an account that would settle definitely the disputed point as to who was the original inventor.

G. W. Clarke.
7316 Lafayette Ave., Chicago, April 14, 1911.

[Portland cement, as it is known to-day, is a development and not an invention, so it is difficult to pick out one man to whom the honor of original discovery may be ascribed. Throughout the last half of the 18th century and the first quarter of the 19th, men were working on various perfections of the hydraulic lime first made in 1756 by Smeaton for his Eddystone Lighthouse, but although some of these experiments included the proportioning of various lime and clay compounds to be ground and burned together to form the cement—a marked improvement on Smeaton's simple burning of a natural rock—none carried the burning to the point of incipient fusion, which is the recognized essential in a Portland cement. Among these men was a bricklayer named Joseph Aspdin, of Leeds, Eng., who went farther than some others of his contemporaries apparently only in procuring, in 1842, a patent on his product, which he called "Portland cement," because, according to modern authorities, of the fancied resemblance of the set cement to Portland stone, an English limestone. Aspdin tried to establish factories for the manufacture of this cement but none of his attempts were highly successful, largely on account of mechanical defects in the plants and the uncertainty prevailing as to the correct proportioning of the ingredients.

Some time between 1840 and 1850, it was found by the various manufacturers of hydraulic lime and "Portland cement," so-called, that burning to incipient vitrification produced a cement of much stronger and more stable qualities and beginning then, the manufacture of Portland cement as now known, was developed. There is no definite record of just when this latest development started or who were the men behind it, but according to his own testimony, in a curious little pamphlet published a few years ago, the venerable I. C. Johnson, was among the first. About 1840 he left the well-known firm of White & Sons, cement and lime manufacturers, where he had introduced many improvements in their machinery, to take over a run-down plant where Aspdin or his successors had been manufacturing the underburned "Portland cement" of his invention. In this plant Mr. Johnson probably turned out the first real Portland cement, and founded the modern cement firm of I. C. Johnson & Co., Ltd. Although he undoubtedly was responsible for many of the methods and much of the machinery that made Portland cement a superior product, there is no evidence that he was the first to realize the importance of high burning temperatures.—Ed.]

Concerning Engineers' Compensation.

Sir: The thought and attention which you have devoted to the subject of licensing engineers leads me to the hope that you will take up the matter of compensation to engineers with the same thoroughness and helpfulness.

That the majority of engineers seem to get the short end of the lever is well known. But the reason is not so well known or will not be admitted so freely. The engineer as a rule is his own worst enemy. He does not stand up for his rights. He is lacking in the conception of the dignity of his calling. He will stand an amount of abuse and cussing that degrades his calling and his manhood. He will work for a salary or fee so small that an investor thinks no more of his value than he does of his cheap clerk at $50 a month. A man will seldom get any higher rating than that which he gives himself.

When one sees men flaunting the high-sounding title of consulting engineer who go around begging for the privilege of designing important structures at bookkeepers' wages, the sight disgusts one with the profession.

A man with four years' college training plus five years' experience is offered the princely sum of $75 a month by some corporation or small iron works and he accepts. An engineer with many years' practical experience will assume responsibilities for so little compensation that it arouses the derision of men in other professions.

I trust this letter will be the means of starting a move-

ment that will improve the status of the entire engineering profession. If engineering societies of repute would prohibit their members from accepting as fees less than a certain per cent. of the cost of works, similar to the practice of the American Institute of Architects, it would aid the profession a great deal.

Yours truly,

Barnett Braslow.

25 West 42d St., New York City, April 10, 1911.

[The questions our correspondent brings forward are not to be answered in a word nor are they to be lightly put aside. Undoubtedly the profession is cheapened and the character of its work is cheapened because so much of it is done at too low a price. How is the evil to be remedied? The individual engineer, in almost every case, is powerless to mend matters. He has to engage in a competitive struggle which results too often in the survival of the unfit.

It is chasing after a will o' the wisp to expect to remedy the matter by legislation, limiting the right to practise engineering. The professions of law and medicine have had such legislative fences around them these many years; and there are many more lawyers and doctors struggling to make a living and failing than there are engineers.

The only road toward betterment that we can see is through the action of engineers associated together in their professional organizations. We have enough engineering societies and to spare. It is time that we organized them so that they can do for their members what the members cannot do for themselves. We believe that it is within the possibilities for the engineering societies to undertake reforms which would enable the engineer to get a better price for his work and the public to get engineering work better worth a high price. It is a big task admittedly, but it is worth doing; and if the engineers can't do it for themselves, assuredly nobody else can do it for them.

Curiously enough, after the above letter and editorial comment were in type, we received the letter printed below, whose pertinence in connection with the above discussion will be at once recognized.—Ed.]

Sir: Enclosed please find copy of "Schedule of Charges for Professional Services of Consulting and Construction Engineers," as prepared by a number of representative St. Louis Engineers and endorsed by the Engineers' Club of St. Louis.

Copies of the Schedule can be obtained from the Secretary of the Engineers' Club of St. Louis.

Edw. Flad.

Fullerton Bldg., St. Louis, Mo., April 17, 1911.

SCHEDULE OF CHARGES FOR PROFESSIONAL SERVICES OF CONSULTING AND CONSTRUCTION ENGINEERS.

The following schedule of charges is intended as a guide to engineers and their clients. It is adopted as representing fair and proper compensation for engineering services under the conditions stated, and is believed to conform to the established practice of the leading American Engineers. We recognize the propriety of a per diem or percentage charge varying in amount according to the magnitude or importance of the work involved, or the experience and reputation of the engineer. We reserve the right to depart from the schedule at any time, if such action seems to us wise and proper.

1. For preliminary study and report upon a project or examination of a project prepared by another engineer and report on same:

(a) Charges, $50 to $100 per day for the first two to ten days and $25 to $50 per day thereafter, plus all expenses, including salaries paid assistants, with an allowance of 25% of such salaries for general office expenses.

(b) In lieu of the above, at the option of the engineer, a percentage charge varying from 1 to 2½%.

2. For preliminary study, report and final detail drawings and specifications:

Charges same as under paragraph 1 (a), or at the option of the engineer, a charge of 3½%.

3. For preliminary study and report, preparing detail drawings and specifications, awarding contracts and acting in a general supervisory capacity during construction, including office consultation, but not including continuous supervision, inspection, testing or management—work costing $10,000 or more, 5%.

For work costing less than $10,000 it is proper to charge a fee in excess of 5%.

4. For full professional services and management, including preliminary studies, detail drawings and specifications, awarding contracts, active and continuous supervision, testing and inspection—work costing $10,000 or more 10%.

For work costing less than $10,000 it is proper to charge a fee in excess of 10%.

5. For investigations and reports involving questions in dispute and intended for use in connection with expert testimoy:

Charges—a minimum fee or retainer of $100 to $500, or such larger amount as may be commensurate with the financial importance of the case or the labor involved, with per diem and expense charges as per paragraph No. 1 (a).

6. Where a per diem charge is made, six hours of actual work shall be considered one day. While absent from the home city, however, or while attending court, each day of twenty-four hours or part of a day shall be considered one day, irrespective of the actual hours of time devoted to the case.

7. When charges are based on a percentage of the cost, the commissions as above are to be computed on the entire cost of the completed work, or on the estimated cost pending execution or completion. Payments shall be made to the engineer from time to time in proportion to the amount of work he has done.

8. Traveling expenses as well as any expenses involved in the collection of the data necessary for the proper designing or planning of the structure or project, such as borings, soundings or other tests, and excepting only ordinary measurements and surveys, are to be paid by the client in addition to the commissions herein provided for.

9. When alterations or additions are made to contracts, drawings or specifications, or when services are required in connection with legal proceedings, failure of contractors, franchises or right-of-way, a charge based upon the time and trouble involved shall be made for same, in addition to the commission herein provided for.

10. Drawings and specifications are to be considered the property of the engineer but the client is entitled to receive one complete record copy of same upon payment of actual cost of making copies if no duplicate set is on hand.

Ben. C. Adkins, W. G. Brenneke, Baxter L. Brown, Wm. H. Bryan, B. H. Colby, A. O. Cunningham, Leo C. Dziatzko, E. B. Fay, R. H. Fernald, E. R. Fish, Edward Flad, J. F. Hinckley, M. L. Holman, H. H. Humphrey, A. L. Johnson, J. H. Kinealy, John A. Laird, A. S. Langsdorf, W. A. Layman, John J. Lichter, Richard McCulloch, Robt. E. McMath, Philip N. Moore, Robt. Moore, C. A. Moreno, Richard Morey, L. C. Nordmeyer, J. A. Ockerson, Ernest L. Ohle, A. J. O'Reilly, H. J. Pfeifer, Julius Pitzman, Maxime Reber, S. Bent Russell, R. H. Talt, Arthur Thatcher, Hans C. Toensfeldt, Jas. C. Travilla, J. L. Van Ornum, R. L. Van Sant, Jacob D. Von Maur, E. E. Wall, H. A. Wheeler, J. W. Woermann.

St. Louis, Mo., Sept. 2, 1910

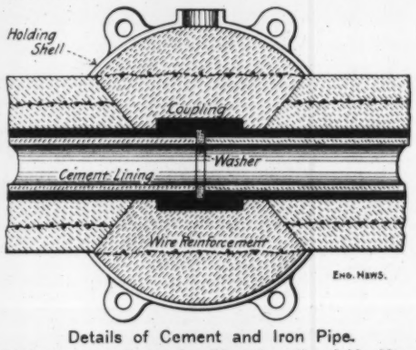
The above Schedule of Charges is endorsed by the Engineers' Club of St. Louis in accordance with a resolution adopted April 5, 1911.

J. D. Von Maur, President; W. W. Horner, Secretary.

Cement-Lined and Covered Wrought-Iron Pipe for Use in Salt Water.

Sir: In reply to Mr. Oscar Ribeiro's request for information concerning the best pipe for laying in salt ground, in Engineering News, Feb. 16, 1911, p. 203, we would recommend the cement-lined and covered wrought-iron pipe which we are now manufacturing, after a number of years of experimentation. This pipe consists of an interior pipe of wrought-iron, lined inside with a cement mortar and covered outside with a coating of cement mortar, reinforced with wire mesh. It is manufactured by a special process that we have developed which results in a very compact mixture of concrete adhering tightly to the wrought-iron.

The form of pipe which should be satisfactory for the purpose stated, and the life of which should prove indefinite under the conditions named, is a 6-in. wrought-iron pipe lined and coated with reinforced concrete and joined with patented couplings, one type of which is shown in the accompanying drawing. Specifications for such a pipe would be as follows:



Details of Cement and Iron Pipe.

(Made by the Composite Pipe Co., Mansfield, Mass.)

Pipe; full rate wrought-iron, 6-in. diameter, 12 ft. long.

Joints; patented couplings or flanged unions.

Lining; concrete wall ½-in. thick, one part Portland cement and one part quartz sand.

Coating; concrete 1-in. thick, one part Portland cement and one part quartz sand.

Reinforcement; standard woven wire fabric embedded in outer coating of concrete.

Waterproofing; paraffin wax.

The patented joint shown consists of a metal coupling of the wrought-iron pipe which is completely covered by cement grout poured in the opening of the metal form, which is bolted together for that operation and which can be unbolted and removed when the concrete sets.

The pipe can be shipped like ordinary cast-iron pipe, at a cost at the ground slightly above that of wrought-iron or steel pipe. Where pipe over 3 ins. in diameter are to be used, we recommend sending our portable plant to manufacture the pipe near where it is to be laid.

The Composite Pipe Co., Inc.,

G. W. Priest, President.

Mansfield, Mass., April 3, 1911.

The Corrosion of Iron and Steel Pipe.

Sir: Your issue of March 23 contains two articles and an editorial on the corrosion of steel pipes, all of unusual interest to students of these problems. Mr. M. J. Falkenburg reports a case of severe corrosion damage occurring on the inside of the return pipes in a steam-heating system, and Mr. F. N. Speller discusses the "much worn" controversy in regard to the relative merits of steel versus iron in welded pipe. Mr. Falkenburg reports that in the case which came under his observation the damage was confined to the return or condensation water zone of the heating system, and concludes that the trouble was due to the remarkable circumstance that the presence of zinc as an alloy constituent, to the extent of from 0.2 to 0.4%.

If Mr. Falkenburg is correct in his conclusion that this case indeed presents a most unusual and remarkable circumstance. Before accepting the conclusion, one would like to examine the analytical data which established the presence of zinc as an alloy constituent of the steel. I know of no problem in the analytical chemistry of iron, which would present greater difficulties to the analyst than the accurate quantitative detection and determination of small fractions of a per cent. of zinc, in iron. In my own practice I might intrust the determination of small amounts of copper or arsenic, or even molybdenum and vanadium, in a sample of iron, to the average routine chemist, but I should scrutinize the attempts to estimate small quantities of zinc, with the most minute and critical attention.

For this reason, if for no others, Mr. Falkenburg's conclusions must be questioned unless based on analytical data of a much more convincing nature than is set forth in his report. If, in a closed-pipe system, galvanized fittings were used, a certain transference and local deposition of corroded zinc would undoubtedly occur and in preparing the samples for analysis, it is necessary to know what was done, before it is possible to believe that the steel contained zinc as an alloy constituent.

Granting, however, that Mr. Falkenburg can substantiate this most unusual iron-zinc alloy as a metallurgical curiosity, we are little, if any, nearer to an explanation of the internal corrosion of closed heating systems. Similar troubles to those inspected by Mr. Falkenburg have been reported over and over again. Are we to believe that in these other cases the accidental alloying of the steel with zinc is the explanation of the trouble?

Mr. Speller in his article gives an excellent resumé of the now commonly accepted explanation of the corrosion of iron, and the active and important rôle played by dissolved oxygen, wherever and whenever corrosion of iron is taking place. With Mr. Speller's explanation, as far as it goes, I am in entire accord.

In every closed heating system, whether it carries steam or hot water, there is sure to be a zone of oxygen concentration where corrosion damage will be localized and segregated. We have here to consider a complex equilibrium, depending upon the following variables at different locations in the system: (a) temperature, (b) pressure, (c) solubility of oxygen, (d) solubility of carbonic acid, (e) electrolytic nature of the water. Considered from this, the only rational point of view, it is not to be wondered at that the principal corrosion damage in a closed system so often occurs at some particular zone or area.

In return condensation systems the damage usually occurs just as it did in Mr. Falkenburg's case, on the condenser side of the system, for at some place in the cooling system the concentration of oxygen and carbonic acid reaches a maximum and corrosion is accordingly accelerated. Engineers in charge of big water-distillation plants are continually meeting this difficulty, and I have more than once been called in consultation on corrosion difficulties in which the "pit holing" had been confined to a narrow band or zone which could be outlined almost between straight parallel lines drawn around the containers. It would appear that Mr. Falkenburg had run into just such a case as this, and if zinc was indeed present as an alloy constituent of the steel, it was not directly responsible for the damage.

Mr. Speller's article appears to go to the opposite extreme of explanation from that advanced by Mr. Falkenburg. If a water has been previously freed from all dissolved gases, the corrosion danger will be reduced to minimum. In my opinion Mr. Speller is absolutely correct in this statement, but Mr. Speller's article carried to its logical conclusion seems to suggest that the chemical constitution of the iron or steel used in the manufacture of pipe is a matter of minor importance as compared to the chemical constitution of the material to be carried by the pipe.

Mr. Speller claims that Bessemer steel pipes under service conditions are as durable as, if not more durable than, iron of a far higher grade of chemical purity. Mr. Speller is an able and eloquent advocate, and under the conditions which maintain in a plant in which it is possible to free water from dissolved gases, it may be true that less attention need be paid to the constitution of the metal used. There are, however, many pipe lines in service in which the preliminary treatment of the water is quite out of the question. Mr. Speller will

have proved himself indeed an eloquent advocate if he succeeds in persuading engineers and other users of iron and steel that chemical constitution and careful control of the contained impurities in a metal, whether it be iron or steel is not still worthy of their most careful attention. Many people believe that purity in a product is an indication of desirable quality, and this is true in so many instances that it is not to be wondered at that, throughout the whole history of iron, there has been a determined demand for the purest possible iron in all cases in which durability rather than high-tensile strength is especially desired.

In connection, will you permit me to congratulate you on the paragraph of your editorial comment on these articles under discussion, in which you say:

These statements illustrate a curious mixing of theory and fact, which should give way to pure fact before an intelligently compare the economy of Mr. Speller's proposition, to rid the water of dissolved oxygen, with that of using the highest grades of metal or the best protective coatings.

Yours truly,

Allerton S. Cushman.

Institute of Industrial Research, Washington, D. C., April 1, 1911.

The following comments on the editorial note discussing the Speller and Falkenburg articles have been received from Mr. Speller:

Sir: Your editorial note on p. 358 of your issue of March 23, in commenting on my paper on the durability of welded pipe, raises a question as to the relative economy of using a more highly refined form of iron as against the remedy proposed by removal of free oxygen from the water. You characterized the latter as sounding like "pure theory." Is it not practically an axiom that iron is not materially injured by contact with ordinary domestic water, which is free from air, the amount dissolved being so extremely small as to have eluded the investigator for a long time and was only positively proven after the methods of determination had been much refined? The other extreme is probably reached in the action of ordinary water on boiler-feed pipe or hot water service lines from which the data on which my paper is based were collected. More information will, of course, be useful as a guide to the engineer in determining what proportion of the oxygen it will be economical to remove in order to ensure a certain increase in life of pipe, but I believe all who have fully considered the matter will agree that it is worthy of the most careful attention on the part of engineers designing piping systems as offering a ready means of relief from a considerable portion of the trouble experienced under modern conditions.

The general statement which I made that, "practically speaking, in the case of water pipes the amount of corrosion is nearly proportional to the quantity of oxygen brought in with the water," seemed to cover a point which is pretty well established, although more research along this line will certainly do good. Dr. W. H. Walker, in a paper in the Journal of the American Chemical Society, Vol. 20, p .1,260, shows that corrosion of iron is proportionate to the concentration of oxygen in the solution. The chart accompanying this statement was by accident omitted and was later published in the Society's proceedings for March, 1908. This chart shows that the speed of corrosion is a linear function of the concentration of oxygen for mixtures equal to and greater than air. It is considered perfectly safe to assume that, for concentrations less than this, the same would hold.

A careful reading of my paper will make clear that while endeavoring to point out the possible benefit to be derived through freeing the dissolved gases from hot water before passing through service lines, I have not attempted to minimize the influence of careful control over the constitution and contained impurities in iron—quite the contrary.

As to the proposition to use "Ingot Iron," is not this much farther within the bounds of speculation so far as the relative action of natural corrosion on this metal and ordinary well made soft steel is concerned? However that may be (and it is perhaps too early to expect any satisfactory data on this point as yet), there are at present two serious obstacles to using such a highly refined form of soft steel for pipe or tubes. In the first place, a strong weld must be easily made, and experience shows that this requires the presence of a certain proportion of foreign material in wrought iron or steel used for this purpose. Furthermore, most pipe must be easily threaded in order to secure a tight joint, which also requires the presence of other elements in the iron. It should be understood, however, that while the ordinary proportion of these foreign elements found in soft steel are essential to the manufacture of welded pipe, that it is also greatly to the advantage of the pipe manufacturer to secure the utmost *uniformity* in composition. With this point in view, weld steel is made by the National Tube Co. from ore to the finished pipe, the metal being given special attention as to inspection and working so as to give the welder the most uniform metal possible. At the same time a better pipe is made, both as to uniformity of weld and durability under corrosion. This treatment places pipe steel in a class by itself, whether made by the Bessemer or open-hearth process.

The main object of my paper was to add to the facts already accumulated relating to the corrosion of wrought iron and steel when used as pipe, based on the comparison of some 40 cases where these materials had been in use together in the same line carrying the same water. As the wrought iron on the whole was slightly more affected than the steel, it appears that the increase in corrosion must be due to some other cause than the material of which the pipe was made. In the course of this investigation it was found that the worst corrosion occurred where there had been in recent years a considerable increase in the amount of hot water carried through these pipes, which suggested the probable cause of this increased corrosion and a possible remedy.

Some engineers who have studied the question of saving their boilers have applied the treatment to boiler feed waters and to locomotive washing plants of heating the water and allowing it to stand for a few minutes in a tank with a vent to the outside air before passing it into the system, without which treatment corrosion increases at a very serious rate.

My reason for bringing up this matter was to place these facts before engineers. They are very often only too much inclined to shift the responsibility for the trouble on to the manufacturer of the tubes, who you may well believe has enough trouble of his own without shouldering this particular burden.

Yours very truly,

F. N. Speller,
Metallurgical Engineer.

National Tube Co., Pittsburg, Pa., April 8, 1911.

A copy of Mr. Cushman's letter has been read by Mr. Falkenburg and the following reply has been received:

Sir: Mr. Cushman seems to question my findings of zinc in the metal of which the pipes in question are composed. It is my opinion that zinc is not such an unknown metallurgical curiosity, nor are the analytical methods for its detection and quantitative determination so extremely difficult that with proper care and precaution very accurate analyses cannot be obtained.

Mr. Cushman incorrectly quotes me when he refers to my finding "this most unusual iron-zinc alloy" as I clearly stated in the article that it was my opinion, based upon fact, that the "zinc is not alloyed with the iron or other metals in the pipe, but that it is present in the metallic state and is diffused in minute particles throughout the pipe-metal." As to whether the corrosion of the pipes in other hot water systems has been caused by zinc being contained in the pipe-metal, or to other causes, I am unable to say. But it certainly is a fact that if zinc was present in the pipe-metal of pipes in a hot-water system, in the same form that it is present in these pipes, corrosion would take place very rapidly.

I would willingly give in detail at this time, the manner in which the pipe-metal was sampled and the methods of analysis used were I not prohibited from so doing until the case, involving a large sum of money, is finally adjusted. In my article I offered to submit samples to any one desiring same for his personal investigation and this offer has already been accepted by many of the leading authorities on iron and steel corrosion. It would seem as though it would have been more befitting for Mr. Cushman to have done likewise if he has any great interest in this matter from a scientific standpoint.

With regard to Mr. Cushman's statement relating to "corrosion difficulties in which the 'pit holing' had been confined to a narrow band or zone which could be outlined almost between straight parallel lines drawn around the containers" and his inference that my case is of that nature, I am at an entire loss to know from what statement in my article such an inference can be logically concluded, and that is certainly not the fact in this building.

Yours very truly,

M. J. Falkenburg.

95-99 Yesler Way, Seattle, Wash., April 14, 1911.

Load Tests for a Suspension Bridge.

Sir: The reference by Professor F. E. Turneaure in your issue of April 13, 1911, to the calculation for the Manhattan Bridge (suspension type) in New York City, induces me to point out the excellent opportunity which this bridge offers, before it is opened for traffic, for testing the results of the calculations, as severally made by Prof. Turneaure and Mr. Moisseiff. The tests can easily be made and would be a most useful contribution to our knowledge in the behavior of large bridge structures under loads.

Ordinarily calculation furnishes a surer index of the strength of a bridge than mere loading tests. But in the Manhattan Bridge the accuracy of computed results depends upon certain assumptions, a slight variation in which may cause considerable divergencies in the calculated stress values.

This suspension bridge has four planes of cables and stiffening trusses, stiff floorbeams with four supports, and metal towers with rigid base, to which the wire cables are fastened at the top. All these features contain statical uncertainties. An additional uncertainty may appear later, if it has not already appeared, from motion of the anchorages. Both anchorages, I believe, rest on vertical piles in a sand formation. If slanting piles had been used there would be no cause for apprehension; but vertical piles can furnish no great resistance to horizontal movement. That such movement is not improbable may be judged from the anchorages of the old Brooklyn Bridge (only 1,500 ft. away). Both anchorages moved after the bridge was opened to traffic. I, myself, saw the cracks in the stone coping and masonry in 1884. They amounted to about 2 ins. on the New York side and 1½ ins. on the Brooklyn side. Each of these anchorage abutments rests also in a sand formation, but on a timber grillage, which offers greater resistance to horizontal motion than vertical piles liable to tilt. The old anchorages came to rest and the masonry was repaired years ago. The movement had no injurious effect upon the bridge structure, because the wire cables resting upon roller bearings (now corroded and inactive) on top of the stone towers, could adjust themselves at that time to that movement.

A similar movement of the anchorages in the Manhattan Bridge would result in permanent and possibly serious bending stresses in the steel towers, because they have a rigid base, and have the cables fastened to their tops.

The loading tests which I suggest would not be expensive and should be made systematically, to a preconceived plan. The test loads should be brought upon the bridge in a number of different positions and covering various lengths in each span. The deflection and stresses in the towers, cables, stiffening trusses, etc., should be computed in advance for each of such positions, and then the stresses ascertained with extensometers while the loads are on the bridge. If the observed deflections and stresses agree with the computed values, it would be a convincing proof of the correctness of the calculations. If they do not agree, then the cause for the disagreement could be ascertained, and such corrections made in the theoretical assumptions as to bring them into agreement with observed facts. When the bridge is once opened for traffic, bending tests could not be made without stopping traffic, therefore they should be made now. These tests would furnish a most valuable aid in the judgment more particularly of the behavior of the towers, and also in respect to the bending stresses in the cables at the towers. These had been estimated at a round ten per cent. It is not improbable that measurements with extensometer may show larger variations than ten per cent. from combined temperature changes and loads. There should be no self-deception as to the towers, anchorages and cables. If these three elements of a suspension bridge are safe, nothing serious can happen. Stiffening trusses may be overstressed without fear of a disaster. This is in contradistinction from a cantilever bridge, in which the failure of a single truss member will and did bring down the whole structure.

Confirmation from actual tests of the computed stresses is advisable in the Manhattan suspension structure, as in no other bridge, because of its peculiar statically indeterminate construction, its uncertain anchorages, and its large size.

Gustav Lindenthal.

45 Cedar St., New York City, April 17, 1911.

[Proof of the above letter was submitted to Mr. K. L. Martin, Commissioner of Bridges and formerly Chief Engineer of the Department of Bridges. Mr. Martin's reply follows.—Ed.]

Sir: Referring to Mr. Lindenthal's suggestion that the Manhattan Bridge calculations be checked by imposing test loads on the structure, this matter was gone into quite thoroughly at the time of Mr. Modjeski's study of the bridge, and it was found that owing to the absence of connections to existing lines of railway traffic, the cost of imposing the necessary loads would be prohibitive. Since that time, the bridge has been opened to both roadway and foot travel.

As to the effect of a possible movement of the anchorages on the stresses in the towers, there need be no apprehension in the matter. All bending stresses in the towers have been fully provided for, and as a movement of the top of the tower of some two feet may occur under certain conditions of congested loading, the effect of the small movement resulting from the slight displacement of the anchorages as suggested would be inappreciable.

Kingsley L. Martin,
Commissioner of Bridges, City of New York.

13 Park Row, Manhattan, New York City, April 25, 1911.

Notes and Queries.

J. V. B.—Kansas City, Mo., asks which is the preferable way to make the computation in solving the following problem: Find the weight of 45 steel bars ½ in. square and 20 ft. long, assuming the weight of steel at 480 lbs. per cu. ft.

A computes thus: $.0417 \times .0417 \times 20 \times 45 \times 480 = 751.5$ lbs.

B. solves it: $\frac{\frac{1}{2} \times \frac{1}{2} \times 240}{1{,}728} \times 45 \times 480 = 750$ lbs. (using cancellation which enables much of the work to be done by mental arithmetic).

Our own preference is decidedly for B's method. It is more rapid, and is easily checked mentally by the computer to be sure that he is making no gross errors.

Renewal of Kentucky River High Bridge.

By H. H. STARR.* Assoc. M. Am. Soc. C. E.

The Cincinnati, New Orleans & Texas Pacific Railroad of the Queen & Crescent Route crosses the Kentucky River at High Bridge, Ky., 21 miles south of Lexington, and just below the junction of the Dix River with the Kentucky. Along this portion of the river the water has dug a course for itself in a deep and wide chasm in the limestone formation. At the bridge site this is about 250 ft. deep to ordinary water level and is about 1,200 ft. wide. The cliffs are either precipitous or stand at a very steep slope with bottom lands on one or both sides of the river. The building of a bridge across this chasm was therefore no small undertaking when the railroad reached this point.

The Old Bridge.

SUSPENSION BRIDGE PROJECT.—As originally planned, Mr. John A. Roebling was to build a bridge of the suspension type. Accordingly in 1854 there was started the building of the towers and anchorages on either side of the chasm; these were completed, but further work was suspended because of financial difficulties due to the panic of 1857. The towers, which can be seen in Figs. 1 and 4, were built of limestone quarried near the bridge site and stand upon the edges of the chasm 1,240.9 ft. apart c. to c. Each consists of two shafts 33 ft. 3 ins. c. to c. rising to a height of 85 ft. 5 ins. above the base of rail. Each shaft is 16 ft. 7½ ins. by 24 ft. 7 ins. at the base of rail, tapering to 7 ft. 2 ins. by 8 ft. 2 ins. at the top, the larger dimensions parallel to the track; the shafts are joined together by a semi-circular arch beginning at 56 ft. above the base of rail, and 16 ft. 2 ins. high from springing line to top of coping, which is 13 ft. 3 ins. below top of shaft.

No further work was done about building a bridge at this point until some 20 years later, when the Cincinnati Southern Railway, owned by the City of Cincinnati, built its line from Cincinnati, O., to Chattanooga, Tenn., in the '70s, and bought and used as a part of its line the old Lexington and Danville railroad. The deed conveying this road reads as follows:

> "Resolved that the Cincinnati, Lexington & East Tennessee Railroad hereby agrees to sell and convey to the trustees of the Cincinnati Southern Railway all the line of railroad belonging to this company from its north terminus in Lexington to its south terminus at Nicholasville, Ky., together with all graded roadbed between Nicholasville and Danville, and all the grounds, rights-of-way, depots and other buildings and structures, including the towers and anchorages for the Suspension Bridge on the Kentucky River."

THE CANTILEVER BRIDGE.—At this later time the Cincinnati Southern asked for bids and designs for a bridge across the river at this point, and on July 9, 1875, awarded the contract for both the superstructure and the masonry to the Baltimore Bridge Co., Mr. C. Shaler Smith, president, and designer of the bridge. Mr. Thomas Rogers was subcontractor for the masonry; the iron work was fabricated by the Edge Moor Iron Co., of Wilmington, Del., while Mr. Smith erected the superstructure himself.

The bridge, Fig. 1, is of the cantilever type with three spans, each 375 ft. long c. to c. Each of the two end spans consists of a 300-ft. suspended span and a 75-ft. cantilever arm, while the center span, of length 375 ft. c. to c., resting on two pyramidal towers, serves as the anchor span. The bridge is of deck type and carries a single track. The trusses are pin-connected, 18 ft. apart and 37.5 ft. deep c. to c. chords, with panels 18.75 ft. long; they are of the multiple-system type, having two web systems. Both top and bottom chords are stiff members built up of plates and angles, and have pins passing through them, forced to place by hydraulic pressure. All diagonal members are eyebars packed on the pins outside of the chord. The posts also are of sections built up from plates and angles or I-beams and channels; they have no connection to the pins, simply bearing against the chords, and the floorbeams frame into them at the top.

The towers are each composed of four columns, forming pyramids 173.5 ft. high, which rest upon limestone piers. At the base they are 71.5 ft. wide by 28 ft. long c. to c. of columns, each column base resting on two nests of rollers at right angle to each other to facilitate movement under temperature changes.

The piers of limestone masonry were carried down to a depth of about 286 ft. below base of rail, to rock foundations.

As the depth of the ravine would have made falsework very expensive, and as frequent and heavy rises of the river made falsework unsafe in the center, or channel span, the method of cantilever erection was determined upon. Briefly, it consisted of cantilevering the span out from the north abutment to a point 10 panels out, where a wooden tower had been erected to support the span as it was cantilevered still farther out to the tower, which in the meantime was being erected with gin-poles to meet the span. The north half of the center span was then built out half way. Anchorage for the cantilevering of the north span was obtained by anchoring the top chord with bars to the base of the stone tower. Temporary additional rods were used in the tower end of the span to provide for the transmission of erection stresses in the web system. The south half of the bridge was then built out in a similar manner until it met the north half at the center of the center span. The structure now being a continuous girder over four supports, two of them being at varying elevations, it became necessary to cut the bottom chords of the shore spans at the fourth panel point out from the tower and so place the structure in the condition as apparently designed—that of a cantilever bridge.

The official record of the railroad st...

The erection of the superstructure com... 12, 1876, was prosecuted without interrupt... the bad weather of the winter and comple... 1877.

The bridge was successfully tested April ... Owing to the inclemency of the weather on... the test, instrumental observations of the def... each operation could not be taken with ac... were sufficient to show the remarkable rigidi... fect elasticity of the structure.

The total cost of the entire structure ($40... less than the estimated cost of completing t... sion Bridge, commenced by Roebling, the t... anchorages of which were already built.

The cost of superstructure was.....$2...
The cost of substructure was.....1...
The weight of iron in spans was..2,85...
The weight of iron in towers was..788...

The old drawings state the bridge ... highest in the world, being 275.5 ft. fro... rail to low water at that time, and 28... bottom of foundations. (Dams ha... raised the level of the water in the riv...

The New Bridge.

Although the old structure is still ... good physical condition, the increase in weig... of the rolling stock made it imperative to replace this bridge with a heavier one. Opportunity was taken in the renewal of this bridge to improve the alinement and eliminate the heavy down grades which approach the bridge from both directions. These grades made it necessary in hauling heavy freight and passenger trains to use two engines, and in some cases a helper in addition. The base of rail of the new bridge was therefore raised 31.3 ft. above the old location.

At first it was intended to build an entirely new structure—an arch bridge, 200 ft. east of the existing one, so as to avoid interruption of traffic during the building operation; but the final design settled upon was for a new structure on the old location.

DESIGN.—The new bridge is of the riveted deck truss type and has three simple spans, each 353 ft. long, resting upon steel towers and abutments, with two plate-girder spans 55 ft. and 69 ft. long, one at each end of the bridge. The trusses are 31 ft. apart c. to c., 73 ft. deep, of 6 panels each 58 ft. 10 ins. long, subdivided to 29 ft. 5 ins. for the floor and lateral systems. The floor system is connected to the posts below the top chord. Each tower has two vertical bents 22 ft. apart longitudinally of the bridge and about 160 ft. high, 31 ft. wide c. to c. of columns at top and 78 ft. wide at bottom. The tower is divided vertically into four bays or sections. The old piers were made use of, but were increased in height by the addition of a reinforced-concrete cap about 14 ft. thick, to give room for the placing of the new tower on the pier. Although but two lines of stringers are placed at present, the new structure is designed for double-track E-60 loading to provide for future second track.

The plate-girder approach spans frame into the

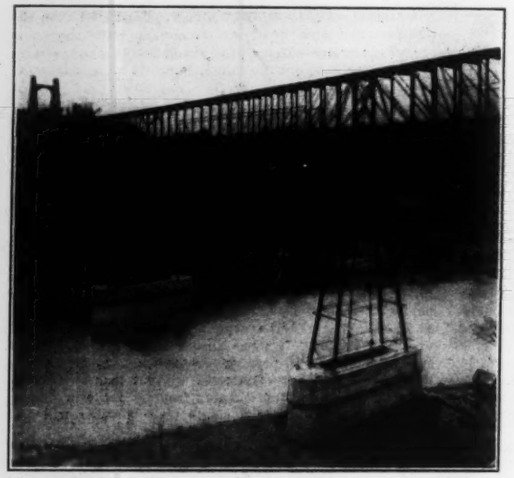


FIG. 1. THE OLD KENTUCKY RIVER HIGH BRIDGE.

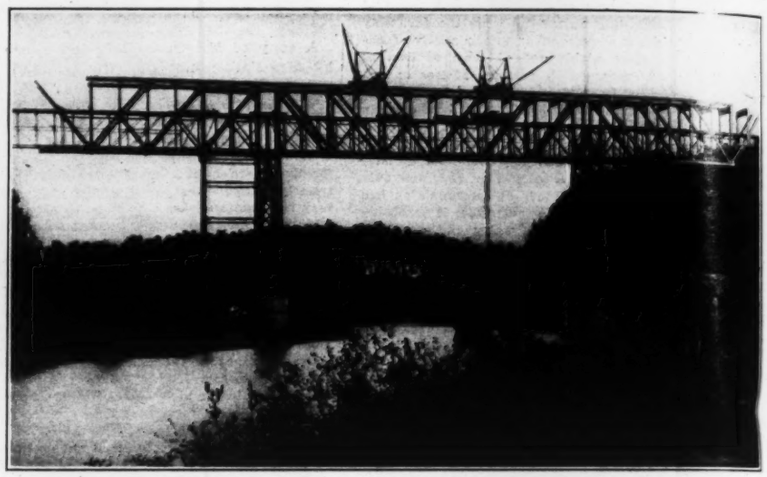


FIG. 2. NEW HIGH BRIDGE, SHORTLY BEFORE COMPLETION; CENTER SPAN JOINED.

*Asst. Engineer, Erection Department, American Bridge Co. of New York, Philadelphia, Pa.

end floor beams and into cross girders which rest in pockets in the old stone towers.

The new structure being upon the old alinement, it became necessary to construct the new work entirely surrounding the old and allow the traffic in the meantime to be carried on the old structure under the new floor-system. This raises the base of rail 31.3 ft. above the present one, making the distance from base of rail to bottom of foundations 315.66 ft. according to railroad records.

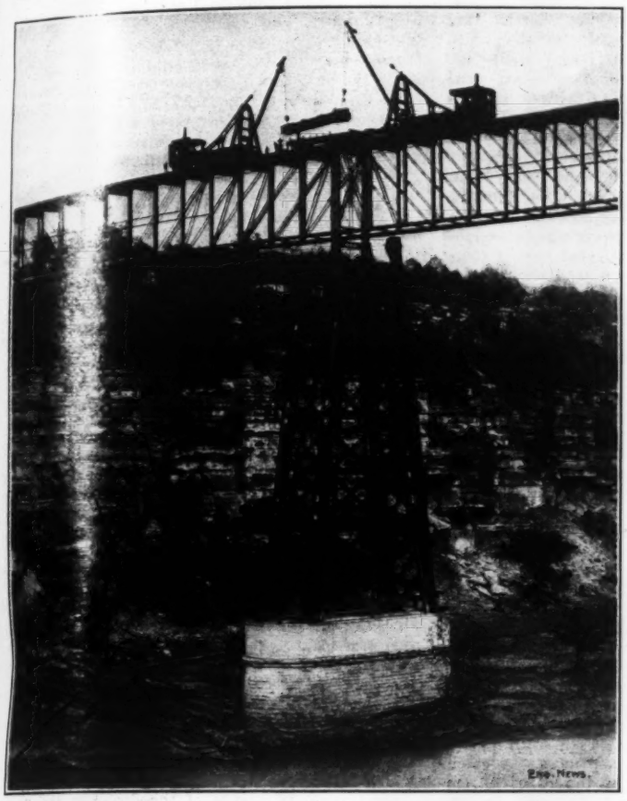


FIG. 3. SETTING NEW NORTH TOWER; DERRICK-CARS OPERATING ON DECK OF OLD STRUCTURE.

As any accident affecting the old structure would probably be of serious consequence, and as the great height of the bridge above the bottom of the chasm made falsework in the erection very expensive, it was therefore imperative that a safe and economical method of erection be decided upon. The method finally chosen was considered to be the best under the circumstances and, briefly, consisted of building out from each tower in each direction by cantilevering and balancing over the tower and a temporary bent (Fig. 6) until the arms of the center span met at the middle; then building out from the abutments to meet the uncompleted portions of the shore spans.

The material forming the members is heavy, and the gusset plates are quite large. On this account it was thought best to assemble the trusses as a whole at the shop, ream all field holes while the members were in place, and match-mark the joints, thus insuring proper fit and quicker erection in the field.

SPECIAL DERRICK-CARS.—Since considerable of the work at the beginning had to be handled by a derrick-car standing on the old structure, and as the old floor-system was too weak to allow the car to handle heavy loads while resting upon it, it first became necessary to adapt the car to these conditions. This was done by strengthening the front bolster, adding stiff legs and connecting links on each side of the car to widen its base to 18 ft., which was the distance apart of the old trusses (Fig. 4). Lengths of 24-in. I-beams were provided, upon which the car was blocked while lifting; these I-beams extended over two panels of each old truss and were blocked upon and anchored to the old chords at the panel points. After the derrick-car had moved out to the proper position the stiff legs were moved out over the I-beams, the connecting links dropped to place and the car wedged up on the I-beams and anchored to them, thus relieving the old floor-system of all load at the front end of the car, except that of the truck. By blocking on the I-beams at the center of an old panel the load could be put into both web systems of the truss (Fig. 5).

In the fall of 1909 preparations for the receipt of material were made by establishing a yard to the north of the bridge, and foundations for the temporary bents were prepared.

ERECTION OF TOWERS AND TEMPORARY BENTS.—Each of the temporary bents first used was located under the first main panel point of the shore span away from the tower, and consisted of two columns 31 ft. apart at the top and 87 ft. 1¼ ins. at the bottom, braced transversely by horizontal and diagonal bracing, and braced longitudinally to the new towers by horizontal struts. The columns themselves were each formed of two pieces of bottom chord (L0-2 and L2-4) and a post (U2-L2) of the permanent material, with additional splice and cap plates and castings to adapt them to the work. The material for the north temporary bent was taken from the south end of the south span, while that for the south temporary bent was taken from the north end of the north span.

The foundations for each bent consisted of a cluster of piles, 42 in each cluster, under the foot of each column, capped with 12 × 12-in. timbers, upon which were placed two tiers of 24 in. 80-lb. I-beams to receive the load and distribute it over the piles. The maximum estimated load was about 15 tons per pile, with an additional load of about 6 tons per pile from wind (at 20 lbs. per sq. ft.), a total of 21 tons per pile.

On the north shore the piles were driven down through firm earth of a clay-like nature until about flush with the ground. On the south shore, however, the bent fell just at the water's edge in very soft mud overlying the rock bottom. As the mud was of a soft nature, and as the piles stood about 15 ft. out of water, loose rock and earth were dumped in up to the water level and the piles afterward driven through this to the rock bottom.

The erection of the new towers (Fig. 3) was begun April 21, 1910, the north one being completed on May 9 and the south one on May 21. The method of setting the column sections was as follows: The main derrick-car, or the car which set all column sections to place, always faced north toward the material yard. At the time of setting any column section the main car moved out to position under its own power and was wedged and anchored to the 24-in. I-beams. The second or helper car, facing south, moved out with the column ahead of it on a flat car and was in turn wedged and anchored to other 24-in. I's. The boom of the main car was set at the proper reach for setting the column in position, the falls of both cars hooked on, the section picked from the flat car, swung over the side of the bridge and slacked into the falls of the main car, which lowered it to approximate height, then swung out and landed it in permanent position. In the meantime the helper car had been cut loose and backed off the bridge, and by this time (if there was sufficient time between trains) had brought out a second section. As soon as all columns of each section or bay were set, all transverse and all longitudinal bracing was placed. The heaviest column section weighed 24 tons; the bottom section weighed 22 tons and was swung out 36 ft. from the center of the bridge. The cast bases weighed 14 tons and were swung out 39 ft. from the center of the bridge. As part of the transverse bracing on the two lower bays fouls the old tower while in permanent position, these two bays were set in a temporary position to clear the old work until such time as the old tower can be removed.

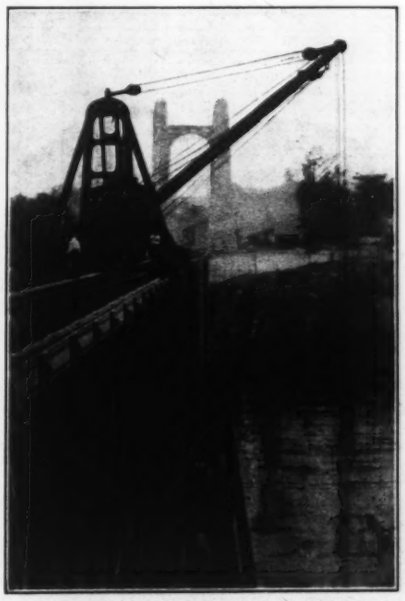


Fig. 4. Derrick-Car Setting Lower Section of South Temporary Bent.

Fig. 5. Picking Up Top Section of Temporary Bent at North Abutment, (One Derrick-Car at Each End of Member).

FIGS. 4 AND 5. VIEWS SHOWING MEANS FOR SUPPORTING THE DERRICK-CAR ON THE OLD STRUCTURE BY SIDE EXTENSIONS WEDGED ON DISTRIBUTING BEAMS OVER TRUSS CHORDS.

After erection, both towers were riveted up as fully as possible. The time required in setting two column sections averaged approximately two hours for the whole operation.

On July 7 the erection of the temporary bent at the north end of the south span was started, the members being handled by two derrick-cars. Owing to the difficulty of temporarily bracing the columns of the lowest section until the permanent bracing could be placed, these two columns were laid upon the ground, the transverse bracing set, and the section then tripped to an upright position by two sets of falls running from the top of the new tower to the upper end of the bent section and operated by the spools of the derrick-car, which was anchored to the track at the south end of the bridge. The other two sections of each column were set by the derrick-cars directly to place, being handled in the same manner as the tower columns. The north temporary bent was set in a similar manner between July 19 and August 3, there being some delay due to the non-arrival of material.

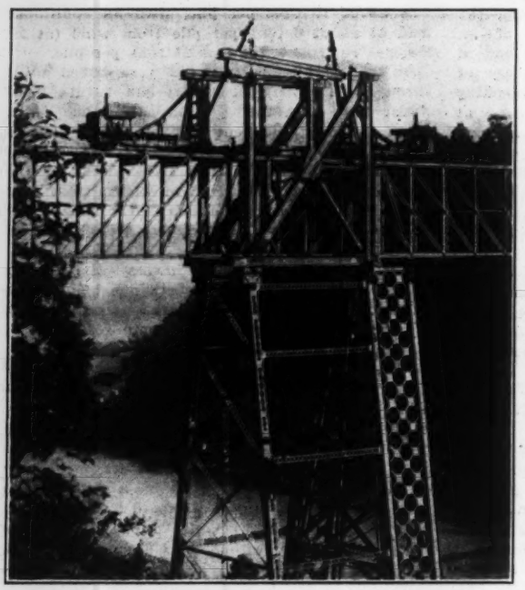


FIG. 6. BEGINNING TRUSS ERECTION ON NEW TOWER AND TEMPORARY BENT; NORTH SPAN.

Previous to using the car the various positions of the car, from which the members would be handled, were determined upon and the stresses in the old structure computed to determine the safety of the old structure while under these loadings.

White-oak blocking, upon which the bottom chord was to rest, was placed upon the top of each temporary column in two piles, leaving a space between them for the setting of a 500-ton jack.

PREPARING FOR ERECTION OF TRUSSES.—After completing the temporary bents the 24-in. I's were moved to the south tower and the derrick-cars erected the first panel of the south shore span, which rested upon the tower and the temporary bent. The truss members and bottom laterals were erected first, and the floorbeams afterwards placed by jacking the top chords apart to allow the beams to slip down between them. The stringers for the two sub-panels were placed, and the traveler was erected upon this panel. The derrick-cars next erected the first panel of the north shore span, as well as its traveler. Either one or two cars were used in handling each member, as was deemed most advantageous.

TRAVELERS.—The travelers (see Figs. 2 and 9) were duplicates, each consisting of a steel platform of girders and I-beams mounted on wheels at the corners, with an A-frame and one boom in the middle of each end; the A-frames were braced together by a strut connecting them at the top and by diagonal bars running to the corners of the platform. Two hoisting engines were mounted on each traveler and operated the ¾-in. wire cables of the boom and hoisting falls; 13 parts of line were used for the boom falls, 9 parts for the load falls. The travelers ran upon traveler-runs on the top chord, consisting of 8 × 16-in. timbers laid flat, with rails spiked to them.

TRUSS ERECTION.—Active erection of the spans with the travelers began on Sept. 12, when various members of the first panels of the center span were set, and was continued until Oct. 6, when the center span was connected. A calculated positive reaction at the top of each temporary bent and at L0 of at least 90,000 lbs. per truss was maintained throughout the work by moving the travelers back and forth and setting various members, first in the center span and then in the shore span, as shown in the accompanying diagram (Fig. 7). To increase the anchorage, the bottom chords of the shore spans were anchored to the temporary bents and the bents to their foundation. The point L2 of each shore span was erected 1⅛ in. lower than L0 at the tower, and the lengths of the tension members U0-U0 and the compression members L0-L0 over the towers were varied from 22 ft. so as to raise L6 of the center span 10 ins. above the horizontal through L0 and insure its not being below the proper position for connecting the center span. As a matter of fact, L2 of the shore span and L6 of the center span were greater distances from the horizontal, due to compression in the blocking, the temporary bent and the foundations.

By measurements made after the towers were erected, it was found that they were not exactly 375 ft. apart, and when the last piece of bottom chord were about to be set, the gap in the trusses were found about an inch too short to allow the entrance of the chords. This was overcome by placing 30-ton jacks between the old and the new towers and springing the new towers apart as far as possible; then when a train passed over the old bridge the deflection of the center span forced the towers a little farther apart and the chords were slipped into place.

After setting all main truss members and most of the floorbeams and bracing of the center span, the L2 points of the shore spans were jacked up until the top chords came together at the U6 joint; then by using special drifts the connection of the U4-L6 diagonal of the south half of the span was made to the gusset at L6.

The travelers then filled in as much as possible of the U6-4 panel of the shore spans and removed the temporary bents.

On Oct. 18 the 24-in. I's were set at the north end of the old bridge, and on the 19th there was started the erection of the temporary steel bent which had formerly been near the north tower. Because of the higher level of the foundations only two sections of columns were used instead of three. The lower half of the bent was erected on the flat and tripped by manila falls operated from the derrick-car. The top sections were then set and braced and the bent fastened longitudinally to the old structure with wire cables.

On Oct. 22 the derrick-car began the erection of the first panel of the north shore span at the abutment end (Fig. 8) in the same manner as at the tower. The trusses and bottom bracing were erected first, the floorbeams being omitted to allow the derrick-car to run out on the old bridge. The traveler was then advanced to the center of the shore span and assisted the derrick-car, which faced south, in setting the members of the second panel. Because of the droop in the arm of the span cantilevering from the tower, L0 and L2 points were erected in a lowered position so as to continue this curve and leave a gap in the top chord for clearance.

After placing all the truss members the L0 points were jacked up so as to close the opening in the top chord at U4, and with the assistance of special drifts to connect U2-L4 to the gusset at L4. After the remaining floorbeams and bracing were placed, the span was on Nov. 7 jacked high enough to set the 30-in. segmental rockers and to drive out the 12-in. pins from the shore ends of the tension members U0-U0, which connected the north to the center span, over the north tower. For jacking purposes the two cross girders for

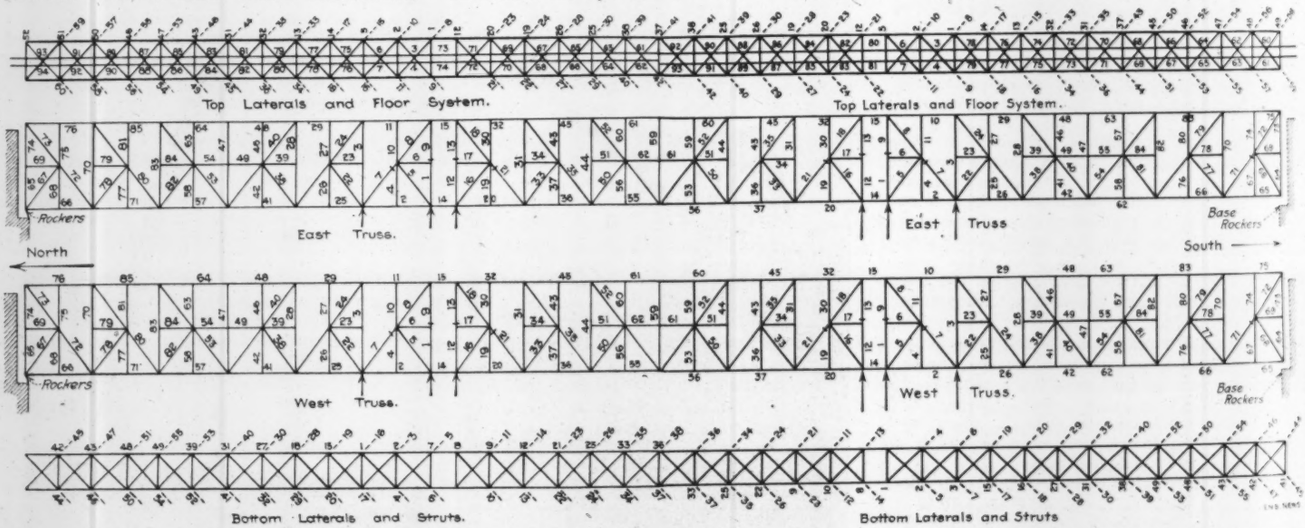


FIG. 7. DIAGRAM SHOWING SEQUENCE OF MEMBERS IN ERECTION TO BALANCE THE CANTILEVER LOADS OVER THE TOWER-AND-BENT SUPPORT.

use at the stone towers were temporarily bolted to the end posts U0-L0 and the span raised by four 500-ton jacks.

After the traveler had removed the temporary bent at the north abutment, work was transferred to the south end of the bridge. The same

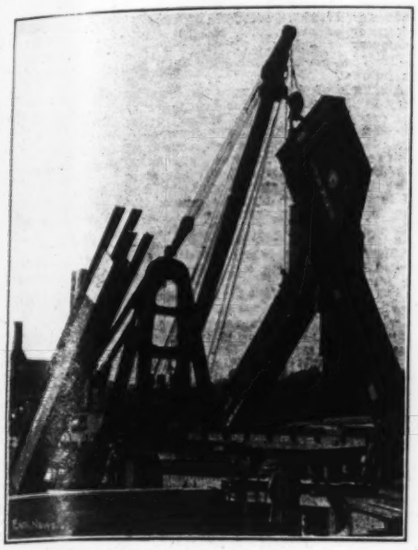


Fig. 8. Detail View of Steelwork, New Kentucky River High Bridge. (Setting North End Post).

method was pursued there as at the north end, except that a timber bent 44 ft. high was used instead of a steel one, and in place of the cross girders there were used short 24-in. I's spanning each cast base, with two jacks resting upon them and jacking against the gusset plates at L0. After completion of the south span, Nov. 29, 1910, the traveler placed the girder span at the south end of the bridge, and from there proceeded to set all the stringers for the whole length of the bridge and the girder span at the north end.

In the meantime riveting had been started on the bottom chord joints and bottom laterals, using oil forges for heating the rivets. After all possible erection had been completed all forces were turned to riveting and the traveler used for carrying swinging scaffolds, forges and rivet supplies, during the riveting of the upper chord joints.

As trains are yet operating upon the old bridge, owing to the non-completion of the approaches by the railroad company, the upper panel of sway bracing has been omitted until such time as trains can be run over the new structure. Many of the lower panels of sway bracing are in a temporary position, due to the interference of the old diagonals. After the removal of the old structure these will be changed, and the rods lengthened by short pieces and sleeve nuts.

The total weight of the new bridge is 7,046 tons. The heaviest member handled by one derrick-car was L0-2, weighing 26 tons. The heaviest member handled by the traveler was L4-6, weighing 34½ tons.

NEW APPROACHES.—The track at the north end approaches the bridge on the general surface elevation, while at the south end it leaves the bridge through a rock cut. As the new base of rail is 31.3 ft. higher than the old one, a change in the approaches was necessary. At the north end this was cared for by a heavy fill to one side of the present temporary alinement and a wooden trestle at the immediate end of the bridge. At the south end, girders span the cut and carry the stringers and track for deflecting the traffic to a new alinement.

ENGINEERS AND CONTRACTORS.—All masonry work was done by the railroad forces, Mr. Horace Baker, general manager, and Mr. Curtis Dougherty, chief engineer, Queen & Crescent Route.

All plans were prepared and all work, both shop and field, was performed under the direction of Mr. Gustav Lindenthal, New York City, consulting engineer for the C. N. O. & T. P. R. R. Co.

The shop drawings were made and the steel work was fabricated at the Ambridge plant of the American Bridge Co. Erection was done by the Eastern Division Erecting Department, American Bridge Co. of New York, Mr. H. P. Lofland, general manager of erection; Mr. J. B. Gemberling, division erecting manager; Mr. Daniel Burns, foreman in charge of the field work at High Bridge, and the writer as resident engineer in charge.

The writer is indebted to Mr. Curtis Dougherty for data regarding the cost and official records of the old structure.

A General Testing Laboratory for the City of New York.

The Board of Estimate and Apportionment of the City of New York on March 31 approved of the establishment of a municipal testing laboratory and has requested the Board of Aldermen to recommend (to the Board of Estimate and Apportionment) the authorization of a $15,000 issue of special revenue bonds to provide necessary equipment and salaries to begin immediate work. This procedure practically assures the establishment of this much needed service, as the Board of Estimate and Apportionment and the Board of Aldermen are believed to be in harmony in this work. However, final action of the Finance Committee of the Aldermen and of the Board of Aldermen has not been taken (April 18).

The report of the Commission on Standardization of Supplies, made to a special committee of the Board of Estimate, explains the proposed plans as follows:

Board of Estimate and Apportionment, Feb. 27, 1911.
The Committee on Standardization of Supplies, Board of Estimate and Apportionment, New York City.

Sirs: The Commission on the Standardization of Supplies, begs herewith to recommend the creation of a thoroughly equipped, adequately manned and centrally situated Standard Testing Laboratory for:

(1) The testing of samples of all kinds of general supplies purchased by the City of New York for the use of the various departments, and for the purpose of securing a proper audit of all claims therefor.

(2) The testing of all materials used in construction work and in the laying and resurfacing of pavements, roadways and sidewalks in the five boroughs of the Greater City.

(3) The carrying on, concurrently, with the routine of general testing, and along specific lines of the city's needs, of such research work as will give the various city departments the benefit of the best available scientific knowledge, worked out practically along definite lines suggested by the routine of general testing, as indicated herein.

(4) The supplying to the Commission on Standardization of the scientific and technical data now urgently required in the work of preparing adequate and efficient specifications for the purchase by the city of all kinds of supplies.

(5) The simplification of the work of auditing and inspecting claims for supplies and materials furnished the city under properly drawn specifications, prepared by the Commission on Standardization and promulgated by the Board of Estimate and Apportionment, for use by all city departments. Co-operation in preparing specifications and in auditing and inspecting claims for work done and supplies furnished thereunder, so that the city shall, by the faithful carrying out of the specifications, receive full value for money expended.

(6) The gradual evolution of uniform methods and standard tests of all supplies and materials purchased for city purposes, and the promulgation to all city departments, by means of monthly bulletins, or otherwise, of the results of such tests, and the research work based thereon. The object of the dissemination of this information would be to enable city departments interested to know fully and accurately the results in efficiency and economy of the general practices prevailing, and experiments made by every other department. This would prevent mistakes made by one department being repeated in others, as at present, and make methods by which valuable results are obtained in one department, available to all others, instead of, as at present, each department being permitted to work independently and in comparative ignorance of what is being done by other departments.

(7) The maintenance of records showing the relative life and relative good, or bad, qualities of all materials used by city departments in construction work, especially of materials used in the laying of pavements and sidewalks, and in the making and surfacing of streets and roadways with macadam and road oils, wood blocks, asphalt, granite setts or other materials. These records to be so kept as to inform departments in charge of such work, not only as to the best and most suitable materials to be used, but to demonstrate, from actual tests of such roadways and sidewalks made during a course of years, the reasons for their durability or lack of durability; information of this character to be disseminated from time to time in monthly bulletins, or otherwise, for the information of all city departments.

(8) The furnishing to the Corporation Counsel's office of such technical data, taken from the results of tests, and from the official records of such tests, as might be required from time to time, to protect the city's interest in legal actions for damages involving materials and supplies furnished to, and work done for, any city department. At the present time large amounts of money are annually expended for expert services and testimony in such actions for damages. It is submitted that such services and testimony could be furnished by the staff and official records of a Standard Testing Laboratory, in a manner and with a completeness which would much more efficiently and far more economically protect the city's interests than they are at present protected in all such legal actions.

Considering all the purposes which the creation of a Standard Testing Laboratory would serve in increasing efficiency and promoting economy in the administration of city business, and in view of the fact that large sums are being authorized by the city to be expended for the creation of laboratories to be used purely for educational and scientific research work ($58,000 authorized Feb. 9, 1911, to equip a new pathological laboratory in connection with the new Bellevue Hospital), the Commission respectfully recommends:

(1) That a Standard Testing Laboratory be established upon the general lines indicated herein, under the direct control of the Board of Estimate and Apportionment.

(2) That the laboratory be located in the new Municipal Building in Park Row, when that building is ready for occupancy, and that application be made at once for the necessary space and special facilities required.

(3) That a committee of the Board of Estimate and Apportionment be appointed to report upon the establishment of such salary grades as may be necessary to secure the immediate appointment of the head of such a laboratory, in order that the organization may be planned and carried out with as little delay as possible.

(4) That in order to supply present needs, especially in the making of coal tests required under the new specifications for the purchase of coal, promulgated by the Board of Estimate and Apportionment for the use of all city departments, the operation of the small testing plant located in the Barron Building, corner of Franklin St. and W. Broadway, be continued. This laboratory is partially equipped with the apparatus

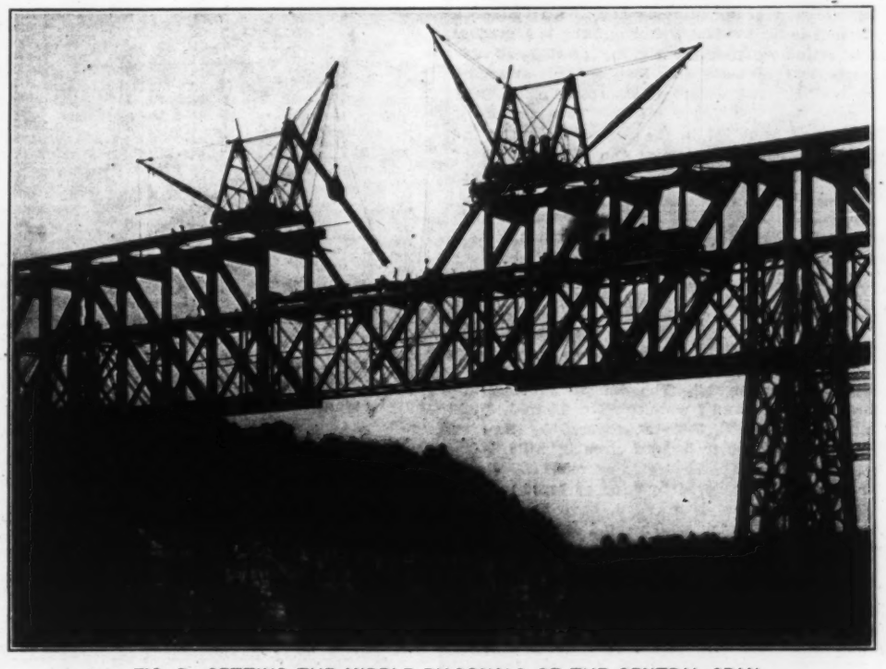


FIG. 9. SETTING THE MIDDLE DIAGONALS OF THE CENTRAL SPAN.

necessary to do the testing work most urgently required under all new specifications for the purchase of supplies promulgated by the Board of Estimate and Apportionment. The Commissioner of Accounts, at the request of the Commission on Standardization, has renewed the lease of these quarters for a year from May next, and is willing to have the laboratory temporarily maintained under his nominal direction until it is transferred to the Board of Estimate and Apportionment. That the work of this temporary laboratory shall be so planned as to form the nucleus of the new Standard Testing Laboratory and ultimately become a part of it.

(5) That special revenue bonds in the amount of $15,000 be authorized to cover the preliminary work of organizing the new Standard Testing Laboratory, and to provide the necessary equipment and the salaries of the necessary staff of chemists and assistants to begin work at once in the temporary laboratory at the corner of Franklin St. and W. Broadway.

Respectfully submitted,

EDMUND D. FISHER, OTTO H. KLEIN, CHAS. N. SWIFT, HENRY BRUERE, H. RAPHAEL, J. L. PULTZ, Commission on Standardization.

W. J. GAYNOR, Mayor; WM. A. PRENDERGAST, Comptroller; JOHN PURROY MITCHEL, President, Board of Aldermen; Select Committee on Standardization.

The resolution of the Board of Estimate and Apportionment approving of the foregoing plan is as follows:

Whereas, The Select Committee on Standardization of Supplies, appointed by the Board on January 14, 1910, composed of the Mayor, the Comptroller and the President of the Board of Aldermen, has recommended the establishment of a Standard Testing Laboratory under the direct control of this Board; be it

Resolved, That this Board hereby approves of the plan for the establishment of a Standard Testing Laboratory, and be it further

Resolved, That the Committee of the Board on the Establishment of Salaries and Grades, be instructed to report upon the creation of such salary grades as may be necessary for the organization and carrying out of the work planned; and be it further

Resolved, That the Committee of the Board on the Allotment of Space in the new Municipal Building be instructed to provide adequate space in the said building for the projected Standard Testing Laboratory; and be it further

Resolved, That for the purpose of providing means for the preliminary work of organizing the new Standard Testing Laboratory, and to provide the necessary equipment and the salaries of the necessary staff of Chemists and Assistants to begin work at once in the temporary laboratory, the Board of Aldermen be requested to recommend to the Board of Estimate and Apportionment the authorization of an issue of special revenue bonds, under the provisions of subdivision 8, section 188, of the Charter, in the sum of fifteen thousand dollars ($15,000).

New Specifications of the National Fire Protection Association for Rubber Covered Electric Wires.

It has long been known that the specifications of the "National Electric Code" of the fire insurance underwriters for "rubber"-covered wire have been quite inadequate in shutting out inferior goods and in reducing the fire hazard from defective insulation. Manufacturers were able to produce a cheap wire for jobbers, who had to meet stiff competition, which would at first meet the code requirements but which might be unsafe in a year or two. In the new specifications a combination of electrical, physical and chemical tests has been effected which it is believed will shut out the low grades. It is estimated that the rigidity of the new demands will increase the cost of code-standard "rubber"-covered wire by 15% (for No. 14 B & S. gage; less for larger sizes). This means an increase of some 3% in the cost of an entire installation. On this account the old qualities of code-standard wire will be permitted until present contracts expire.

ELECTRICAL TESTS.—The changes are shown in the following extracts from the new code specifications. Sections 41-b to d (inclusive) apply to voltage classes from 0 to 600.

Rule 41-b. The insulation must consist of a rubber compound, adhering to the conductor or to the separator if one is used and of a thickness not less than that given in the tables 41, e and f.

(The old rule 41-b permitted "rubber or other approved compound." The old thicknesses, according to 41-e and f were, for No. 14 to 1, 3-32-in.; No. 0 to 0000, 3-32-in., covered by tape or braid; for 250,000 to 500,000 circular mills, 3-32-in., covered by tape or braid; over 500,000 circular mils, 1/8-in., covered by tape or braid.)

The old sections, 41-c and d, have been partly combined in revising. The old section, 41-e, merely demanded an insulation resistance of 100 megohms per mile of wire during 30 days immerison in water at 70° F. The old section, 41-d, is contained in the new section, 41-c, as shown below:

Rule 41-c. Any 1-ft. sample of completed covering must show a dielectric strength sufficient to resist throughout five minutes the application of an e.m.f. proportionate to the thickness of insulation in accordance with the following table:

Thickness in 64ths inches.	Breakdown Test on 1 ft.
1	3,000 volts A. C.
2	6,000 " "
3	9,000 " "
4	11,000 " "
5	13,000 " "
6	15,000 " "
7	16,500 " "
8	18,000 " "
10	21,000 " "
12	23,500 " "
14	26,000 " "
16	28,000 " "

The source of alternating e.m.f. shall be a transformer of at least 1 KW. capacity. The application of the e.m.f. shall first be made at 3,000 volts for five minutes, then the voltage increased by steps of not over 3,000 volts each held for five minutes, until the rupture of the insulation occurs. The tests for dielectric strength shall be made on a sample wire which has been immersed in water for 72 hours. One foot of the wire under test is to be submerged in a conducting liquid held in a metal trough, one of the transformer terminals being connected to the copper of the wire and the other to the metal of the trough.

The new section, 41-d, which fills the vacancy left by the transfer of the old section, reads thus:

Every length of completed wire or cable must be tested after not less than 12 hours' immersion in water and while still immersed by the application for one minute of an alternating-current voltage derived from apparatus of ample capacity, the test voltages to be those given in the tables of 41-e and f.

After this voltage test every length of completed wire or cable while still immersed must show an insulation resistance after one minute electrification not less than the values given in 41-e and f.

Any length of completed wire or cable may be tested during 30 days' immersion in water and must show not less than 50% of the insulation resistance required after the 12 hours' immersion.

The results of insulation test at different temperatures to be reduced to a basis of 60° F. (15.5° C.) by using the multipliers in the following table:

Temperature, degrees Fahrenheit.	Multiplier.
50—52	0.69
53—55	0.78
56—58	0.88
59—61	1.00
62—64	1.12
65—67	1.27
68—70	1.43
71—73	1.60
74—76	1.81
77—79	2.04
80—82	2.29
83—85	2.58

The simple statement of thickness of insulating wall for classes from 600 to 3,500 volts in the old section, 41-e, already quoted above, has been replaced by more elaborate requirements.

Rule 41-e. Thickness of insulation, voltage tests and minimum insulation resistance to be in accordance with the following tables. The test voltages are to be for one minute. The insulation resistances are after one minute electrification and at 60° F. (15.5° C.).

TESTS ON COMPLETED LENGTHS 0-600-VOLT CLASS.
(Type Letters R. S.)

Size.	Thickness of insulation.	Megohms per mile after twelve hours' immersion.	Voltage test one minute.
14	3—64	300	1,500
12	3—64	250	1,500
10	3—64	225	1,500
8	3—64	200	1,500
6	1—16	200	2,000
4	1—16	150	2,000
2	1—16	125	2,000
1	5—64	150	2,500
1—0	5—64	125	2,500
2—0	5—64	125	2,500
3—0	5—64	100	2,500
4—0	5—64	100	2,500
225,000 circ. mil.	3—32	100	3,000
300,000 " "	3—32	100	3,000
400,000 " "	3—32	100	3,000
500,000 " "	3—32	100	3,000
600,000 " "	7—64	100	3,500
700,000 " "	7—64	100	3,500
800,000 " "	7—64	100	3,500
900,000 " "	7—64	100	3,500
1,000,000 " "	7—64	100	3,500
1,250,000 " "	1—8	100	3,500
1,500,000 " "	1—8	75	3,500
1,750,000 " "	1—8	60	3,500
2,200,000 " "	1—8	50	3,500

The tests laid down for completed lengths in 600 to 7,000-volt classes are still more amplified but it seems unnecessary to reprint the tables here.

MECHANICAL TESTS.—The physical tests, to which all rubber-covered wires will be subjected, are set forth in the new section, h, which reads as follows:

Rule 41-f.—All physical tests to be made at a temperature between 60° and 90° F. All test samples to be kept at a temperature within this range for at least two hours before the tests are made.

(1) The rubber compound or other approved insulation must be sufficiently elastic to comply with a test made as follows:

A sample of wire about 20 ins. long shall have the braid and insulation removed for about 2 ins. at each end, leaving the braid and insulation on balance of sample. One end of the bare copper should be fastened to a clamp on a shaft of the diameter given below and a weight as given below attached to the other end of the bare copper wire. The shaft shall then be revolved ten times in ten seconds, wrapping the sample in a close wind around the shaft. With the tension between the sample it should then be immersed in water for 24 hours, immediately after which it should, while still immersed, be subjected to 1,500 volts, alternating current, for one minute. The braid shall not crack under the above test

	B. & S.	Mils.
Diameter of shaft.....	No. 14 wire	170
Diameter of shaft.....	No. 12 wire	190
Diameter of shaft.....	No. 10 wire	275
Diameter of shaft.....	No. 8 wire	375

(2) The insulating covering shall be tested for thickness as follows:

A sample of wire to have the braid removed without injury to the insulation for a distance of about 2 ins. and the exposed surface held against a flat surface and subjected to the pressure of a hard phosphor bronze edged tool, the sharpness of whose edge shall be that obtained by two surfaces forming an angle of 90° with each other.

With the tool edge at right angles to the length of the wire a vertical pressure of 8 lbs. applied perpendicular to the flat surface for 15 minutes, shall not cut through the insulation and complete an electric circuit as indicated by a 16-c.p., 110-volt, carbon lamp in series with the tool and wire conductor.

(3) Any rubber compound used as insulation shall be tested for permanent set, elongation and tensile strength as follows:

A.—For New Wire.—A test piece taken from the wire, having insulation less than 5/64-in. thick, shall have marks placed 2 ins. apart, and shall be stretched longitudinally at the rate of 12 ins. per minute till the marks are 3 ins. apart, and then be immediately released and a measurement taken 30 secs. thereafter, when the distance between the marks must not exceed 2.5 ins. The test piece shall then be stretched until the marks are 6 ins. apart before rupture. The tensile strength shall not be less than 400 lbs. per sq. in., calculated upon the original cross-section of the test piece before stretching.

Test pieces from wire having insulation 5/64-in. thick or over shall be tested in a similar manner, but shall be stretched to 4 ins. instead of 5 ins., and must not break until stretched 5 ins., and shall have a tensile strength of 400 lbs. per sq. in.

B.—For Wire Tested at Any Time Up to One Year from Date of Manufacture.—A test piece taken from wire having insulation less than 5/64-in. thick shall have marks placed 2 ins. apart, and shall be stretched longitudinally at the rate of 12 ins. per minute till the marks are 4 ins. apart, and then be immediately released and a measurement taken 30 secs. thereafter, when the distance between the marks must not exceed 2.5 ins.

Test pieces from wire having insulation 5/64 in. or over shall be stretched at 3½ ins. instead of 4 ins.

CHEMICAL TESTS.—The prescribed chemical tests for the insulating material are found in a new section (41-j).

Five chemical tests shall be made of the rubber compound as follows: Acetone extract, alcoholic potash extract, chloroform extract, ash and total sulphur content.

The sum total of the results of these five tests shall not exceed 80% by weight of the total compounds—tests to be made according to Underwriters' Laboratories' specifications.

The ash test shall be supplemented by tests to determine the quality of substances other than vulcanized rubber which are combustible but not soluble in acetone, alcoholic potash or chloroform and any such substance shall be counted as ash.

Notes From Engineering Schools.

UNIVERSITY OF WISCONSIN.—A special course in public health has been established. The course will occupy a year, and on its satisfactory completion a diploma will be granted. The course is designed particularly for city and town health officers, and among other things will include a study of water-supply, sewage disposal, disinfection, bacteriology, public health administration and vital statistics.

The University regents have approved the recommendation recently made by Mr. John Nolen, Cambridge, Mass., for the acquisition of about 350 acres of what is now farm land, directly west of the present boundaries of the institution. The area has a frontage on Lake Mendota. Mr. Nolen has made plans for the improvement and extension of the grounds of the University.

A TANK CAR EXPLODED April 22 at St. Louis, Mo., in the yards of the Bell Oil Co. Four persons were killed and ten others injured. Reports state that the car was filled with gasoline.

A SOUTH AFRICAN RAILWAY ACCIDENT April 22 resulted from the collapse of the Blaauwkrantz bridge on the Kowie Ry. while a train was crossing. About 30 persons were killed and many others injured.

TWO ROUNDHOUSES WERE BURNED recently. At Omaha, Neb. April 15 fire destroyed the 18-stall brick-veneer house of the Chicago, St. Paul, Minneapolis & Omaha Ry. at 14th and Manderson Sts. Ten engines were damaged. The total loss is estimated at $50,000. The same figure is given for the loss in the case of the roundhouse and repair shop of the New York, New Haven & Hartford R. R. at Danbury, Conn., which were destroyed by fire April 25. Three locomotives were ruined by this fire.

A COAL MINE EXPLOSION AT ELK GARDEN, W. Va., April 24, wrecked the No. 2 Ott mine of the Davis Coal & Coke Co. and entombed 22 miners. The explosion caused heavy falls of roof, according to reports, which will considerably delay the work of the rescue parties.

A SPEED OF 141.7 MILES PER HOUR was attained by a motor-car over a straight course on the beach at Daytona, Fla., April 23, when a measured mile was covered in 25.40 seconds. This was done by "Bob" Burman in a 200-HP. Benz car known as the "Blitzen." A new world's record for two miles was established on the same date by the same car and driver, 51.28 seconds, equivalent to 140.4 mi. per hr. The speed attained for the mile is just 10 mi. per hr. more than that made on the same track March 16, 1910.

PROGRESS OF THE STRAWBERRY TUNNEL.—To date 11,196 ft. of this tunnel (total length, 19,200 ft.) have been excavated. The progress during March was 260 ft. The prevailing material encountered was red and gray sandstone, with occasional strata of limestone. Water dripped from the roof at the face during the entire month, making it difficult and unpleasant for the workmen. The flow of water from the mouth of the heading is about 7 cu. ft. per sec. The best rubber clothing can not keep out the cold water, and the men are constantly quitting, the average time worked being from 5 to 10 shifts.

The work of lining the tunnel with concrete is following the excavation, 359 ft. of the sides and arch and 908 ft. of floor lining having been put in during the past month. In order to put in the bottom lining the floor is unwatered by means of a cofferdam and two 14-in. pipes. The water is backed up 2 ft. or more in depth and the pipes are laid along each side of the tunnel a few inches above grade, extending through the cofferdam. This scheme is considered preferable to pumping, as it saves the wages of three pump-men. The bottom is unwatered in 500-ft. sections. A recent snowfall put the roads in such condition as to cut the tunnel off from the rest of the world, all freighting having been suspended; a box of emergency provisions was placed in the tunnel near the heading, containing pilot bread, pork and beans, tomatoes, etc.

The tunnel is part of the Strawberry Valley Irrigation project, in Utah, and is to bring water from the Colorado River drainage basin through the Divide into the Great Basin. Its capacity will be about 500 cu. ft. per sec.

A REMARKABLY SPEEDY HYDROPLANE MOTOR-boat has been developed by Sir John I. Thornycroft in his latest model "Maple Leaf III." According to London "Engineering" this boat made in a trial trip between 58 and 60 miles per hour over a measured course exceeding a mile and for longer trips, under two-thirds power, an average speed of 40 knots or about 46.5 miles per hour. The "Maple Leaf III." is the latest development of the hydroplane model on which its maker has been experimenting some years. It is 40 ft. long with a beam of 9 ft. and is driven by a 650-HP. gasoline engine. There are twin screws, each connected to 12 cylinders set at an angle to the vertical in the form of a V. The engines are started by a small auxiliary engine, in order to avoid the usual laborious starting by bars or other physical effort.

THREE ARRESTS FOR DYNAMITING were made on Saturday, April 22, 1911. The charge against two of the men is complicity in the blowing up of the Los Angeles (Cal.) "Times" building on Oct. 1, 1910, where about 20 persons were killed; the other man is charged with being concerned in another Los Angeles explosion. J. W. McNamara and one McManigal were arrested in Detroit on April 11 on another charge and came with detectives to Chicago, where they were turned over to California officers on extradition proceedings April 22. On this day J. J. McNamara, a brother of one of the two, was arrested in Indianapolis and also extradited to California. The last named is secretary of the International Association of Bridge and Structural Ironworkers. All three men belong to ironworker circles. On the following day two large secret stores of dynamite were found by the detectives, one in a shed in Tiffin, Ohio, and the other in the building containing the headquarters of the ironworkers' union in Indianapolis.

These arrests are the outcome of a long campaign of detection carried on by bridgebuilding firms to track down the men responsible for a series of dynamitings of bridges, buildings, structural steelwork under construction and contractors' erection appliances, which began nearly five years ago and have continued with increasing frequency and recklessness ever since. The destruction of a coal bridge in Milwaukee, described in our issue of April 13, 1911, p. 438, was one of the most recent of these outrages. The worst by all odds was the wrecking of the Los Angeles "Times" building on Oct. 1, 1910, with 21 deaths; at the same time unsuccessful attempts were made to blow up the home of the owner of the "Times" and the home of the secretary of the Merchants' Association of Los Angeles. The Los Angeles outrage was not at first thought to be of the same series, nearly all the others having been palpably directed against steel construction or erection contractors. But some parts of time-clock mechanism were found, it is stated, that are identical with similar parts found in bridge explosions. Moreover, the man who bought the dynamite used in the "Times" case is said to have been identified as one of the McNamaras.

As we noted in our issue of July 28, 1910, the police of the various cities where dynamitings occurred never succeeded in finding any of the perpetrators. The matter was taken in hand more earnestly after the Los Angeles disaster, and the noted detective W. J. Burns was brought into the case. The National Erectors' Association, formed of steel contractors, had previously followed up all cases as fully as possible. The joint work of these two agencies, it appears, has now brought about the first prosecution for the dynamiting crimes.

THE RIGHT OF CATASAUQUA, PA., TO BUILD and operate water-works, notwithstanding the fact that the borough is already supplied by a private company, has been affirmed by the Supreme Court of Pennsylvania. As we understand the decision, however, this does not necessarily mean that any municipality may build works regardless of whether or not a supply is being furnished by a private company. The suit in question was brought, it appears, by the Clear Springs Water Co., a subsidiary of the Lehigh Coal & Navigation Co., to prevent the borough from putting in operation a plant which the latter had built at an expense of $110,000. A summary of the pertinent facts in the case is given in the following extract from the opinion of the court:

> The act of 1907 authorizes cities and boroughs to acquire water-works owned by private persons and provides the mode of procedure for accomplishing the purpose. It provides that appraisers shall be appointed to value and appraise the property, and that they shall file their report in the Prothonotary's office. The report becomes final if not appealed from ten days after notice that it has been filed. An appeal is allowed, which shall be heard and determined by the Court, which has the power to increase, lower or modify the appraisement. The municipality is authorized to buy the plant at the valuation thus determined, and the corporation owning the plant to file a paper indicating its consent and election to sell and convey the plant to the municipality at the valuation fixed, as required by the act. The fourth section then provides that in default of its consent to sell at the appraised value, the company shall cease to have any exclusive privilege of supplying the municipality or the citizens thereof with water, and the municipality may install such plant or system as the authorities may deem necessary and expedient for the accommodation of the public.
>
> Catasauqua borough presented its petition to the Common Pleas Court of Lehigh County on Dec. 19, 1907, setting forth its desire of owning the water-works of the Clear Springs Water Co., the plaintiff in this case, and asked for the appointment of appraisers under provisions of the act of 1907. The matter was proceeded with to a hearing, when the Clear Springs Water Co. alleged that the act was unconstitutional and had no application to it, which was denied by the borough.
>
> The company cannot be permitted to defeat the borough's application under the act of 1907 by filing a disclaimer and thereby induce the Court to dismiss the application and the borough to expend large sums of money in erecting its plant, and then withdraw the disclaimer and enjoin the borough from completing the water plant.

RAISING AN ELEVATED RAILWAY has been made necessary by the track elevation of the Chicago & Western Indiana Ry. on 40th Ave., Chicago, where it is crossed by the Garfield Park line of the Metropolitan Elevated Ry. The maximum raise was about 12 ft., the lift increasing about 6¾ ins. at each bent. The falsework at each bent consisted of two four-post timber bents, with top and bottom sills and two sway braces. The posts were directly under the girders, and each girder was supported by a wooden block on the top sill. The end posts of the timber bents were connected by sway braces. The raising was done by screw jacks placed under the bottom sills of both bents, one jack directly under each post. Blocking was built up under the sills, and wedged tightly against them when the full height was attained. Traffic was not stopped, but trains reduced speed over this part of the elevated line. In a majority of the bents the columns were lengthened by splicing new portions at the bottom. This has been done in other similar work, but in this case the location on private right-of-way made it practicable to build concrete pedestals under the original columns to the required elevation, the two pedestals of each bent being connected by a curtain wall. The concrete work was done by the Fehr Construction Co., and the concrete was distributed from the mixer by steel cars on a portable narrow-gage track. The raising of the structure and all changes to steel work were done by the Strobel Steel Construction Co.

DAMAGE TO A REINFORCED-CONCRETE STRUCTURE BY ELECTROLYSIS.—It is well known that serious damage can be done to structural steel by electrolysis caused by stray currents from high potential electric service lines. In fact, it is perhaps not too much to say that electrolysis threatens the destruction of millions of dollars worth of property in this country. After a few more serious object lessons have been met with by engineers, it is likely that any expedient that promises to reduce the dangers will be welcome. The writer has himself recently been called upon to inspect and report on a full reinforced-concrete structure which cost $400,000 to build about four years ago and which has been ruined by electrolysis from escaped railway currents. If this form of steel tuberculosis is going to attack the great reinforced-concrete buildings of the present day, the ultimate damage will be appalling.—Dr. Allerton S. Cushman in a paper on "Conservation of Iron" in the "Journal of the Franklin Institute" for April.

Personals.

Dr. Elmer E. Brown, United States Commissioner of Education, has been elected Chancellor of New York University, New York City.

Mr. E. C. Crum, of Crum & Davidson, Frederick, Md., has been appointed City Engineer of that city. Mr. Crum is also County Engineer.

Mr. Mark R. Lamb, of the Allis-Chalmers Co., Milwaukee, Wis., has been appointed Manager of the South American branch of the company with offices at Santiago, Chile.

Mr. John Bristow, of Narragansett Pier, R. I., has been elected Engineer to the State Board of Public Roads of Rhode Island at a salary of $3,000 per annum. Mr. Bristow has been connected with the state highway work for the past 15 years.

Mr. Charles Kiehm, Assoc. M. Am. Soc. C. E., for the past five years connected with the State Engineer's office at Albany, N. Y., and recently Engineer for the Barge Canal Terminal Commission, has resigned and opened an office in the Gardner Bldg., Utica, N. Y., as a consulting engineer.

Mr. Morgan T. Jones, President and Inspecting Engineer of the American Bureau of Inspection and Tests, has resigned his position with that company to engage in the same line of business under the title of Morgan T. Jones Co., inspecting engineers, with general offices in the Monadnock Block, Chicago.

Mr. Herman H. Schmidt, who has been acting Chief Engineer of the Bureau of Highways of the Borough of Brooklyn, New York City, since the resignation of Mr. John C. Sheridan, has received a permanent appointment, having successfully passed the necessary civil service examination on April 5.

Hon. Robert T. Lincoln, President of the Pullman Co., of Chicago, Ill., has resigned on account of ill health. He has been at the head of the Pullman Co. since the death of Geo. M. Pullman in 1897. Mr. Lincoln is Vice-President of the Commonwealth Edison Co. and a director of several other corporations of Chicago.

Mr. B. F. Bush, formerly President of the Western Maryland Ry., has been elected President of the Missouri Pacific Ry. Mr. Bush has been with the Northern Pacific Ry. and other Western roads. He has been President of the Western Maryland Ry. since 1907; previous to then he had been in charge of the company's coal properties.

Mr. Sterling H. Bunnell, M. Am. Soc. M. E., recently Works Manager and Chief Engineer of the Griscom-Spencer Co., of New York City, has opened an office as a consulting engineer and specialist in cost keeping at 90 West St., New York City. He will be associated with Clinton H. Scovell & Co., Certified Public Accountants, of Boston, Mass.

Mr. A. L. Dabney, M. Am. Soc. C. E., has been elected Chief Engineer of the Tallahatchie Drainage Commission, with office at Tunica, Miss. He succeeds Maj. T. G. Dabney, M. Am. Soc. C. E., whose position has been changed (at his own request) to that of Consulting Engineer. The Tallahatchie Drainage District embraces all or parts of seven counties in Mississippi.

Mr. F. J. Sprague, Past President of the American Institute of Electrical Engineers, has been awarded the second Edison gold medal for meritorious achievement in electrical science, and the medal will be presented on May 16 at New York. This medal was founded some five years ago by the friends of T. A. Edison to celebrate the twenty-fifth anniversary of the incandescent lamp. The first medal was received by Prof. Elihu Thomson.

Mr. William McClellan, M. Am. Inst. E. E., President of the McClellan-Lines Co. and Vice-President of the Campion-McClellan Co., of New York City and Philadelphia, Pa., has been appointed Electrical Engineer of the Public Service Commission, Second District, of New York State. Mr. McClellan is a graduate of the University of Pennsylvania and was formerly Engineer-in-Charge of Construction with the Philadelphia Rapid Transit Co.

Gen. Theodore A. Bingham, formerly Police Commissioner of New York City, has been appointed Chief Engineer of the Bureau of Highways of the Borough of Manhattan, New York City, succeeding Mr. Geo. W. Tillson, M. Am. Soc. C. E., who has become Consulting Engineer for the Borough of Brooklyn, as noted in our issue of last week. Gen. Bingham was an officer of the Corps of Engineers, U. S. A., from 1879 to 1904, when he was retired with the rank of Brigadier-General.

Mr. Alexander Robertson, formerly General Manager of the Western Maryland Ry., has been elected President. Mr. Robertson entered the railway service as a brakeman

on the Fitchburg R. R., now a part of the Boston & Maine R. R., in 1885. He was successively, conductor, general yardmaster, stationmaster and trainmaster of the Fitchburg R. R. In 1897 he went to the Wabash R. R., where he became Superintendent of the Middle Division. He has been General Manager of the Western Maryland since 1903. He is succeeded as General Manager by Mr. John A. Shepherd, formerly Superintendent of the Maryland Division.

Obituary.

Rear-Admiral Richard Inch, U. S. N., retired, died in Washington, D. C., on April 21, at the Naval Hospital. He was born in Washington on June 29, 1843. On Sept. 8, 1863, he was appointed Third-Assistant Engineer in the U. S. Navy. He retired from the Navy in 1905 with the rank of Rear-Admiral, after 42 years of active service on many ships. He was Chief Engineer of the cruiser "Boston" at the battle of Manila in 1898. In 1899 he was in charge of the Engineering Department of the Cavite (P. I.) Naval Station.

John Dennis Kelley, Electrical Engineer of the New York Central & Hudson River R. R., died of pneumonia at his residence, 58 Arthur St., Yonkers, N. Y., on April 21. The funeral was held at the Monastery of the Sacred Heart, in Yonkers, on April 24 and the interment was at Holy Cross Cemetery, Brooklyn. A widow and three children survive him.

Mr. Kelley was the son of Major J. D. Kelley, Member of the Board of Education of Brooklyn and a Director of the Brooklyn Rapid Transit Company. He was born in Brooklyn, Feb. 6, 1871, and received his early education in the Christian Brothers' School of that city. He later entered the St. Francis Xavier College in New York City and upon the completion of his course, went to Johns Hopkins University where he took a four-year scientific course, specializing in electrical engineering. Upon finishing this course, in 1893, he undertook civil engineering work in South Carolina. In 1897 his services were secured by the Brooklyn Rapid Transit Co. in connection with the reconstruction of the Brighton Beach R. R. and after a few months he was made Assistant Engineer. His natural work, however, was in the electrical field and his opportunity to enter it came when train-movement tests were inaugurated by the Brooklyn Heights R. R. Co. While on this work, he invented an instrument for registering, automatically and simultaneously, the movement of a train and the readings of electrical instruments carried thereon, to secure the useful time-speed, time-current, and time-voltage curves, side by side on one chart. This device was called by his associates the "Kelleyograph"—a name which it still carries. Mr. Kelley's excellent record led to his appointment as Assistant Master Mechanic of the Brooklyn Rapid Transit Co., in which capacity he acted as technical advisor to the Vice-President. This position he retained until 1903. Upon the organization of the Electric Traction Commission of the New York Central Railroad, Mr. Kelley was asked to become Assistant Electrical Engineer. He entered upon this work Feb. 1, 1903, and immediately began to solve the problems which attended this first great trunk-line electrification. He brought to this work unbounded enthusiasm, a broad experience and a clear logical mind which was the inspiration of all with whom he was associated. His familiarity with civil, mechanical and electrical engineering, in addition to his great mathematical talent, were of the greatest assistance to the Commission and in recognition of his valuable services, he was appointed Electrical Engineer in 1906.

Among Mr. Kelley's inventions, in addition to the "Kelleyograph," were a self-ventilating armature and a hand-brake system for street cars. He also developed many of the practical details of the New York Central type of under-contact third rail. His most valuable contribution to the art of electric railroading was, however, the circuit-breaker house system of third-rail connections which has been the means of saving vast sums in feeder copper. In 1907, collaborating with Prof. S. W. Ashe, he brought out a book entitled "Electric Railways," which is largely used in technical colleges throughout the country.

In Mr. Kelley's death the engineering profession loses one of its most intellectual and resourceful leaders who has left an enviable record in the pioneer field of railroad electrification. The dominant characteristics of Mr. Kelley's character were intellectuality and entire devotion to his work. His mind, although working rapidly, performed its function in an atmosphere of calm and deliberation entirely devoid of prejudice or passion and marked by almost judicial impartiality. While always mindful of the large aspects of his work, he displayed a great capacity for detail, so that nothing ever issued from his office without personal examination. The precision and intelligence of his work was soon noticed and thereafter always commanded the implicit confidence of the higher officials of the railroad. As a worker, Mr. Kelley had few equals. His life was absorbed in engineering work and his keenest pleasure was in accomplishing tasks of great intricacy. When important problems arose demanding the utmost care to secure safety to life or economy, he was at his best. He was an excellent judge of men and this faculty enabled him to estimate accurately the capacity of each of his assistants so that they felt that in him they had a friend who thoroughly appreciated their abilities. On account of his retiring disposition, he avoided appearing in public, but he was nevertheless well known and highly esteemed by a large circle of friends. He was a member of the Engineers' Transportation and New York Railroad Clubs. [Obituary from Mr. E. B. Katte, Chief Engineer of Electric Traction, New York Central & Hudson River R. R.]

Engineering Societies.

COMING MEETINGS.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 15-18. Annual meeting at Chattanooga, Tenn. Secy., D. B. Sebastian, 721 La Salle Station, Chicago, Ill.

AMERICAN RAILWAY ASSOCIATION.
May 17. Semi-annual meeting at New York City. Secy., W. F. Allen, 24 Park Pl., New York City.

OHIO SOCIETY OF MECHANICAL, STEAM AND ELECTRICAL ENGINEERS.
May 18-19. Annual convention at Youngstown, Ohio. Secy., F. E. Sanborn, Ohio State University, Columbus, Ohio.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 23-25. Annual meeting at New York City. Secy., F. H. Wentworth, 87 Milk St., Boston, Mass.

AIR BRAKE ASSOCIATION.
May 23-26. Annual convention at Chicago, Ill. Secy., F. M. Nellis, 53 State St., Boston, Mass.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
May 23-26. Annual convention at Pittsburg, Pa. Secy., Richard Moldenke, Watchung, N. J.

INTERNATIONAL MASTER BOILERMAKERS' ASSOCIATION.
May 23-26. Annual convention at Omaha, Neb. Secy., H. D. Vought, 62 Liberty St., New York City.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
May 29-June 2. Annual convention at New York City. Secy., T. C. Martin, 29 West 39th St., New York City.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 30-June 2. Annual convention at Pittsburg, Pa. Secy., Calvin W. Rice, 29 West 39th St., New York City.

AMERICAN WATER WORKS ASSOCIATION.
June 6-10. Annual convention at Rochester, N. Y. Secy., J. M. Diven, 14 George St., Charleston, S. C.

AMERICAN INSTITUTE OF MINING ENGINEERS.
June 6. Annual convention at Glen Summit Springs Hotel, Luzerne Co., Pa. Secy., Joseph Struthers, 29 West 39th St., New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 13-16. Annual convention at Chattanooga, Tenn. Secy., Charles W. Hunt, 220 West 57th St., New York City.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 14-16. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

MASTER CAR BUILDERS' ASSOCIATION.
June 19-21. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor 390 Old Colony Bldg., Chicago, Ill.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.
June 19-23. Annual convention at Boston, Mass. Secy., P. W. Drew, Wisconsin Central Ry., Chicago, Ill.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 21-24. Semi-annual meeting at Chicago, Ill. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 27-29. Annual meeting at Pittsburg, Pa. Secy., H. H. Norris, Cornell University, Ithaca, N. Y.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 27-July 1. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN CHEMICAL SOCIETY.
June 28-July 1. Annual convention at Indianapolis, Ind. Secy., Charles L. Parsons, Durham, N. H.

NATIONAL ELECTRIC LIGHT ASSOCIATION.—The membership continues to grow rapidly. The increase during the past year has been more than 2,000. The total membership on April 18 was 7,321.

ALBANY SOCIETY OF ENGINEERS.—At the meeting of April 25, Mr. Theodore Horton, Consulting Engineer of the New York State Department of Health, gave an illustrated address on "Water Filtration."

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Several papers on patents and patent law will be presented at the meeting of May 9 in New York City. The subject will be discussed by E. W. Marshall, D. Howard Haywood and Edwin J. Prindle, all of New York.

NEW YORK STATE CONFERENCE OF MAYORS.—The second annual conference is to be held at Poughkeepsie, N. Y., May 25 to 27. Among the subjects to be discussed are street cleaning and maintenance, municipal transit, the commission form of government and municipal water supplies.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—The headquarters for the coming 19th annual meeting at Pittsburg, Pa., will be at the Carnegie Technical Schools. At this meeting, special attention will be given to the reports of the committees on the teaching of mathematics to engineering students and on entrance examinations for technical schools.

UTAH SOCIETY OF ENGINEERS.—The [illegible]ual meeting and dinner was held at the Commercial Club, Salt Lake City, April 20. Mr. John Dern, President of the American Mining Congress, was among those who addressed the meeting. Officers for the coming year were elected as follows: President, M. D. Grosh; Vice-Presidents, C. F. Moore and E. H. Beckstrand; Secretary, R. B. Ketchum; Treasurer, A. S. Peters.

INTERNATIONAL CONGRESS ON HYGIENE AND DEMOGRAPHY.—The 15th congress will be held at Washington, D. C., Sept. 23-28, 1912. The object of the congress is to extend the knowledge and improve the practice of hygiene, public health and vital statistics in the countries which participate. Invitations to participate have been accepted by 21 countries. Occupational diseases and industrial accidents will be taken up by the section of industrial and occupational hygiene. The hygiene of houses and streets, water-supply, disposal of waste and the legislative and administrative functions of boards of health will be discussed before the section of state and municipal hygiene; the section of hygiene of traffic and transportation will take up street traffic, street railways (including subways and elevated lines), railways, river and lake traffic and sea traffic, giving attention both to sanitation and to the prevention of accidents. The six other sections will deal respectively with microbiology and parasitology; dietetics and physiology; hygiene of infancy and childhood; control of infectious diseases, and tropical, military and naval hygiene.

The preliminary announcement states that any person interested may become a member of the congress, entitled to participate in the proceedings and to receive a copy of its transactions, upon payment of the membership fee of $5. The address of the congress is Army Medical Museum, Washington, D. C.

NATIONAL ELECTRIC LIGHT ASSOCIATION.—A tentative program has been announced for the annual convention at New York, May 30-June 2. There will be 16 sessions in all, with 24 papers and some 40 reports. The general calendar of meetings is as follows:

May 30, A. M., First General Session.
Evening, Public Policy Committee: Report on Welfare-Work Plan.

May 31, A. M., First Technical, Commercial and Accounting Sessions.
Afternoon, Second General and Accounting Sessions.

June 1, A. M., First Power Transmission, Second Commercial and Third Accounting Sessions.
Afternoon, Second Technical and Third Commercial Sessions.

June 2, A. M., Second Power Transmission, Third Technical and Fourth Commercial Sessions.
Afternoon, Third General Session.

Among the papers and reports the following are to be noted:

General Sessions.—Reports on Progress, Accounting, Overhead Construction, Insurance, Question Box, Library, Rate Research, Section Organizations, and Changes in Constitution; "Master and Men," by Mr. Paul Lupke; "Electrical Exhibitions," by Mr. L. A. Ferguson; "Valuation of Properties as Related to Rates," by Mr. W. F. Wells; "Reasons for Variations in Rates Under Varying Conditions of Operation," by N. T. Wilcox; "The Standardization of Electrical Selling," by Douglass Burnett; "Economies in Operation Possible Through Time Study," by Mr. L. B. Webster.

Technical Sessions.—Reports on Pole Preservation, Underground Construction, Overhead Construction, Meters, Prime Movers, Lamps, Electrical Apparatus, Grounding of Secondaries; "The Ventilation of Turbo-Generators," by Mr. R. B. Williamson; "Progress and Development in Self-Cooled Transformers," by Mr. H. O. Troy; "Grounding Low-Tension Circuits," by Mr. P. M. Lincoln; "Recent Improvements in Single-Phase Motors," by W. A. Layman; "Relation of Motor Load to Central-Station Equipment," by F. D. Newbury.

Power Transmission Sessions.—Reports on Governmental Control of Water Powers and Lightning Protection; "Utilization of Central Stations for Supply of Electricity to Operate Railroads," by Mr. Fred. Darlington; "A New Method of Reducing the Investment in Central Station Boiler Plants," by Mr. H. A. Wagner; "Determining Cost of Production in Steam Properties Under Varying Conditions," by Mr. G. H. Walbridge.

Commercial Sessions.—Reports on Electricity in Rural Districts, Power, Electric Vehicles, Residence Business, Improved Standards of Industrial Lighting, Advertising, Competitive Illuminants, Sales Departments.

Accounting Sessions.—"Tracing Store-Room Material," by Mr. J. T. Brady; "The Purchasing Department," by Mr. T. W. Buxton; "Advantage of Job Cost System," by Mr. Alex Holme; "Handling Customer's Orders," by Mr. R. F. Bonsall; "Collection of Bills," by Mr. E. J. Bowers; "Electric Vehicle Accounts," by Mr. Herman Stoehrer; "General Office Accounting," by Mr. Franklin Heydecke; "Depreciation," by Mr. H. M. Edwards; "Use of a Tabulating Machine in Accounting Work," by Mr. Wm. Schmidt, Jr.